FOUR ESSAYS ON AGGREGATE INVESTMENT DYNAMICS
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Introduction and abstract

The discrepancy between theory and empirical work is perhaps nowhere in macroeconomics so obvious as in the case of the aggregate investment function.

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Blanchard (1986)

A fundamental tenet of investment theory [...] is that a rise in interest rates has a sizable negative effect on capital expenditures by businesses. [...] Yet, a large body of empirical research offer mixed evidence, at best, for a substantial interest-rate effect on investment.

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Sharpe and Suarez (2014)

Large interest rates reductions, implemented by Central Banks in an attempt to revive economic activity, have failed to boost investment in advanced economies in the long and still ongoing aftermath of the 2007-2008 global financial and economic crisis (Banerjee, Kearns, and Lombardi, 2015; Bryant and Jones, 2015). As testified by the quotes reported above, and most importantly by a large empirical literature,¹ this is just the most recent manifestation of a clear discrepancy (as Blanchard called it) between the traditional view, according to which investment would mainly depend on the interest rate, and the empirical evidence. The resulting need to explore alternative hypotheses is the main motivation behind this dissertation, that consists of four essays on the theory and empirics of aggregate business investment.

While the investigation of the determinants of aggregate investment is the trait d’union linking these essays, the thesis also intersects two other strands of literature:

¹See for example the surveys in Chirinko (1993) and Caballero (1999) or the recent works by Sharpe and Suarez (2014) and Kothari, Lewellen, and Warner (2014)
that on the impact of political factors on economic variables (to which Chapters 2 and 3 aim to contribute) and that on the determinants of long-run growth (in particular in Chapter 4, co-authored with Riccardo Pariboni).

The first essay argues that the empirical difficulties of mainstream investment theory are matched by equally significant theoretical difficulties. The paper surveys the neoclassical theory of aggregate investment and its criticisms. It distinguishes four main formulations of this theory: the traditional ‘Wicksellian’ investment function; the Fish-erian ‘array-of-opportunities’ approach (as Witte jr. called it); the Jorgensonian model; the now prevailing adjustment-costs models.

With respect to other papers criticizing the neoclassical theory of investment (for example Crotty, 1992; Gordon, 1992; Stiglitz, 2011), we do not appeal to market imperfections, but argue that all four formulations present serious theoretical difficulties, even conceding free competition. The derivation of a negative relation between investment and the interest rate relies on the traditional conception of capital as a single homogeneous factor, that has been proved untenable by the so-called Cambridge capital controversies. Marginalist factor substitution mechanisms, on which the theory is based, have been shown to be deprived of theoretical foundations. Old and new attempts to derive the interest-elastic investment function without making recourse to factor substitution (as in the so-called ‘array of opportunities’ approach or in models with convex adjustment costs) are even less solid, because they rest on the mistaken assumption that expected rates of return on investment projects are independent from the interest rate.

In addition to this central problem, that affects both traditional and contemporary neoclassical theory, we discuss some additional issues raised by contemporary models. The dominant approach, nowadays, is to derive demand for capital from the Jorgenson (1963) model, focusing on an atomistic price-taking representative firm, and append an adjustment process based on some assumption regarding the internal costs of adjustment. We discuss the difficulties that this approach encounters in determining the optimal capital stock under constant returns to scale, and the aggregation problems that arise when the investment function of the single firm is applied to the whole economy.

The negative conclusions drawn by the first essay justify the exploration of alternative approaches to investment. The other three papers aim to provide some constructive empirical contribution in this direction.

The second essay takes up the suggestion in Gordon, Weisskopf, and Bowles (1998, p. 236) that empirical analyses of aggregate business investment “would be significantly enhanced if they took account of the institutional environment within which investment decisions occur”. In particular, we try to assess whether institutional-political factors in-
fluence business investment dynamics, by estimating the reaction of business investment to left-wing electoral victories.

The idea that business investment can be sensitive to political shocks has long been discussed, yet existing empirical works have focused on political uncertainty, rather than political partisanship. In this paper we estimate the ‘average treatment effect’ of left-wing electoral victories on aggregate business investment, using a sample of 215 elections in 14 OECD countries in the period 1960-2013. We focus on a subsample of 107 elections in which the Left’s proposed economic policy was relatively more radical in terms of State intervention in the economy. The remaining subsample, in which the Left is more centrist, is used as a sort of control group. We employ a Regression Discontinuity design in order to avoid selection bias arising from the influence of macroeconomic conditions on electoral results, thus focusing on close elections. We find that left-wing electoral victories tend to cause a significant and economically relevant decrease in business investment growth in the two years following the election. This negative impact on investment is not matched by any significant impact on GDP growth.

The third essay carries on the analysis started in the second essay, with further econometric analyses aimed at tracing the cause of the negative effect of left-wing electoral victories on business investment growth.

First, we employ Regression Discontinuity to estimate the causal effect of electoral outcomes on variables that, according to the literature, can influence business investment: the real interest rate, the profit share and stock market dynamics. (The impact on output growth has already been investigated in the previous chapter, finding no statistically significant effect.) We find no impact of left-wing victories on the interest rate and the profit share. However, we do find a strong negative impact on the growth rate of stock market valuations.

Second, we estimate a ‘moving-average’ Regression Discontinuity, in order to track the time-pattern of the effect of electoral shocks on business investment and stock market valuations. We find the impact on the stock market to be partly anticipated, but mostly felt in the three months around an election, when a Left victory tends to decrease the growth rate of domestic share prices by around 1.1 standard deviations on average (which amounts to a decrease in their year-on-year growth rate by as much as around 25%). The impact on business investment growth appears to be spread on the first six quarters after the election, after which it starts to fade out.

Overall our results suggest that political shocks influence business investment through expectations and business confidence, rather than actual changes in macroeconomic conditions, at least in the short-run.
The fourth essay, coauthored with Riccardo Pariboni, discusses and tests empirically the so-called Sraffian supermultiplier approach, according to which in the long-run investment and growth are driven by the autonomous components of aggregate demand (exports, public spending and autonomous consumption). To test empirically some major implications of the model, we calculate time-series of the autonomous components of aggregate demand and of the supermultiplier for the US, France, Germany, Italy and Spain and describe their patterns in recent decades.

A descriptive analysis shows that changes in output and in autonomous demand are tightly correlated, both in the long and in the short-run. The supermultiplier is substantially higher and more stable in the US, while in the European countries it is lower and decreasing. Where the supermultiplier is reasonably stable - i.e., in the US since the 1960s - autonomous demand and output share a common long-run trend (i.e., they are cointegrated). The estimation of a Vector Error-Correction model (VECM) on US data suggests that autonomous demand exerts a long-run effect on GDP, but also that there is simultaneous causality between the two variables. We then estimate the multiplier of autonomous spending through a panel instrumental-variables approach, finding that a one dollar increase in autonomous demand raises output by 1.6 dollars over four years.

A further implication of the model that we test against empirical evidence is that increases in autonomous demand growth tend to be followed by increases in the investment share. We find that this is the case in all five countries. An additional 1% increase in autonomous demand raises the investment share by 0.57 percentage points of GDP in the long-run.
Chapter 1

Old and new formulations of the neoclassical theory of aggregate investment: a critical review

1.1 Introduction

Explaining the dynamics of aggregate business investment has always been a major goal of economic analysis. Investment plays a central role in economic cycles and allows potential output and productivity to grow in the long-run. For the neoclassical (or marginalist) approach, which is nowadays still dominant among economists, the determination of investment is crucial also for a further reason. The negative dependence of investment on the interest rate is necessary, in theoretical models, for establishing a stable full-employment general equilibrium. Without that relation there would exist no ‘natural’ rate of interest capable to ensure that in the long-run investment adapts to full-capacity savings.

But how solid are the theoretical foundations of the neoclassical theory of investment? In this essay we try to answer this question by reviewing critically its four main formulations: the traditional Wicksellian investment function (to which Section 1.2 is dedicated), the Fisherian ‘array of opportunities’ approach (Section 1.3), the Jorgensonian model (Section 1.4) and the now prevailing adjustment-costs models (Section 1.5).

We will try to highlight the aspects that are common to these different formulations, their differences, and how they relate to one another. Particular attention will be dedicated to the criticisms that have been leveled against these theories and to unresolved issues.
Overall, this survey suggests that the neoclassical theory of investment is far from foolproof. The derivation of a negative relation between investment and the interest rate relies on the traditional conception of capital as a single homogeneous factor, that has been proved untenable by the so-called Cambridge capital controversies. Marginalist factor substitution mechanisms, on which the theory is based, have been shown to be deprived of theoretical foundations. Old and new attempts to derive the interest-elastic investment function without making recourse to factor substitution (as in the so-called ‘array of opportunities’ approach or in models with convex adjustment costs) are even less solid, because they rest on the mistaken assumption that expected rates of return on investment projects are independent from the interest rate.

In addition to this central problem, that affects both traditional and contemporary neoclassical theory, we will discuss some additional issues raised by contemporary models. The dominant approach, nowadays, is to derive demand for capital from the Jorgenson (1963) model, focusing on an atomistic price-taking representative firm, and append an adjustment process based on some assumption regarding the internal costs of adjustment. We will discuss the difficulties that this approach encounters in determining the optimal capital stock under constant returns to scale, and the aggregation problems that arise when the investment function of the single firm is applied to the whole economy.

With respect to other papers criticizing the neoclassical theory of investment (for example Gordon, 1992, pp. 427-437; Crotty, 1992; Stiglitz, 2011, p. 594), we will not make appeal to market imperfections or bounded rationality. These elements surely matter in real economies and neoclassical theory can certainly be criticized for not taking them seriously enough. However, if problems were only related to these aspects, it could be argued that the neoclassical model serves as a useful benchmark, which explains what would happen under perfect competition, perfect information and rationality. More realistic formulations could then be obtained by adjusting appropriately the benchmark ‘frictionless’ model, relaxing one assumption or another depending on the problem at stake. Instead, our survey of the mainstream literature and of its criticisms suggests that neoclassical investment theory is unsatisfactory also when the object of analysis is a world of complete and perfectly competitive markets. Of course, if the theory encounters difficulties also without introducing market imperfections, then a stronger critique can be leveled at it, and the case for exploring alternative visions is even more compelling.
1.2 The traditional neoclassical approach: a ‘long-period’ investment function

Since the so-called ‘marginal revolution’ of the late 19th century, the mainstream view has been that investment adapts to savings through the equilibrating role of the interest rate.\(^1\) The idea that investment is determined by the interest rate is closely connected to what has been called the ‘long-period’ version of general equilibrium theory.\(^2\) This approach, followed by early marginalist authors such as Wicksell, Böhm Bawerk or Clark, aims to determine the normal (‘natural’) equilibrium prices and quantities, conceived as centres of gravitation toward which the economy tends in the long-run.\(^3\) Given preferences, technologies and the endowment of production factors, prices and quantities are simultaneously determined in all markets by the intersection of supply and demand curves. Competition and profit-maximization imply that the remuneration of each factor is equal to its (value) marginal product.

1.2.1 The theory of capital and the investment function

In this early marginalist approach, the factor endowments that are taken as data of the equilibrium include the aggregate value of capital. The various produced means of production are indeed seen as embodiments of a single factor, ‘capital’. While the aggregate value of capital is taken as a given, the vector of different capital goods (the composition of the capital stock) is endogenously determined by the tendency to a uniform (risk-adjusted) rate of return across industries. Like a fluid, capital the homogeneous factor can therefore take different forms without changing its overall quantity (Garegnani, 2012, pp.1418-1421).

As in all other markets, equilibrium in the market for capital is determined by the intersection of ‘well-behaved’ demand and supply curves. In particular, a stable equilibrium is ensured by the fact that demand for capital (that is, the quantity of capital that firms on aggregate want to hold) is a decreasing and sufficiently elastic function of its price, the interest rate.\(^4\)

\(^1\)Classical economists as Smith, Ricardo and Malthus took for granted that savings translated into investment, without any reference to the role of the interest rate (see for example the discussion in Garegnani, 1978, pp.25-28).
\(^2\)As opposed to the Walrasian short-period version (Garegnani, 1976; Kurz and Salvadori, 1997; Petri, 1978).
\(^3\)Wicksell (1977 [1934]) probably represents the best expression of this strand of thought.
\(^4\)Early marginalist authors generally acknowledged that supply of capital (in the form of loanable, investible funds that savers are willing to provide to firms) may not be monotonically increasing in the interest rate. For this reason, the demand for capital curve has to be not only decreasing, but also
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The negative slope of the demand function for capital is determined by direct and indirect substitution mechanisms. When the interest rate rises, firms tend to reduce the capital-labour ratio of their production processes, in order to save on the factor that became relatively costlier. Demand for capital decreases. Another force, coming from the demand side, works in the same direction. The relative prices of the more capital-intensive goods increase, so demand for them declines and their share in GDP gradually decreases, again reducing demand for capital. Of course equal and opposite processes will take place when the interest rate decreases. In this way the marginal product of capital is kept in line with its cost: when the cost of capital increases (decreases), the reduction in the K/L ratio of the economy raises (diminishes) also its marginal product.5

From demand for capital to investment  The logic through which investment (a flow) can be derived from demand for capital (a stock) is examined at length by Garegnani (1978, pp. 346 and 352),6 whose account is followed here. If we assume no fixed capital (i.e., all capital is circulating) and annual production cycles, it is easy to see that yearly investment is just equal to demand for capital. The presence of fixed capital makes things more complex, but the essence remains the same: investment is the flow that adds to the stock of capital. Investment will thus rise above (fall below) the level needed to compensate depreciation when demand for capital increases (decreases). The investment function is thus determined by the demand for capital function and (assuming no ‘perverse’ effect of the interest rate on the rate of depreciation) its relation with the interest rate bears the same negative sign.

In this long-period approach, technology is conceived as putty-clay: production factors are substitutable only ex-ante. This makes it possible to determine the level of investment in a given period (e.g., a year). In each year, gross investment is equal to the desired K/L ratio, multiplied by the number of workers released by the scrapping of old plants.7

Note that in analyzing the investment market equilibrium, traditional marginalist

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5 Of course this reasoning relies on the law of diminishing returns. The latter ensures that, economy-wide, the marginal product of one factor is decreasing in its employed quantity, keeping fixed the quantities of the other factors employed in conjunction with it.

6 An even more detailed account, expanding on that of Garegnani, is found in Petri (2004, pp. 127-135).

7 This is of course a simplification, which assumes that all capital is durable. When there is circulating capital alongside fixed capital, a portion of investment will consist in circulating capital goods to be employed in ‘old’ productive plants. As the optimal K/L ratio in old plants is not changeable, this portion of investment will be unlikely to be influenced by changes in the optimal K/L ratio.
theory takes total labor employment as a given – determined by the conditions of equilibrium in the labor market. This is necessary to allow the optimal $K/L$ ratio to determine univocally the optimal capital stock (that is, the long-period demand for capital). Moreover, it is this full employment assumption that justifies taking as given the quantity of labor to be employed in new plants, thus determining the gross investment level in each period on the basis of the optimal $K/L$ ratio to be adopted in new plants.

### 1.2.2 A simple model and a graphical example

A simple formalization can help grasp the traditional neoclassical determination of investment. Take a one good economy (steel is produced by means of labour and steel)\(^8\) with no taxes. Assume perfect ex-ante substitutability between capital and labour. As an exemplification to illustrate quantitatively the idea, we can use a Cobb-Douglas production function, which applies only to new plants in the short-run but to the whole economy in the long-run (even if technology is putty-clay, in the long-period\(^9\) all productive plants will eventually come to adopt the optimal $K/L$ ratio, provided that the latter remains constant for a sufficient lapse of time). We also assume, for simplicity, a rigid labor supply; the market-clearing condition thus reduces to an equality between labor employment and the given supply of labor. Profit maximization requires that the value marginal product of each factor is equal to its price. In a long-period position we thus have

\[
Q = AK^\alpha L^\beta \quad (1.1)
\]

\[
w = \frac{\delta Q}{\delta L} p \quad (1.2)
\]

\[
r = \frac{\delta Q}{\delta K} p \quad (1.3)
\]

\[
p = 1 \quad (1.4)
\]

\[
L = \bar{L} \quad (1.5)
\]

$Q$ is output (the quantity of steel produced); $K$ the capital stock (steel used as capital); $L$ labour (worker-hours); $w$ the wage; $r$ the interest rate; $p$ the (normalized) long-period price of steel.

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\(^8\)Here steel is both the capital good and the consumption good: one unit of steel can either be consumed or employed as a means of production. Wages are obviously also paid in steel.

\(^9\)Note that here the ‘long-period’ does not correspond to that horizon of time in which one can expect prices to converge to production costs, but rather to the longer time horizon in which the equilibrium $K/L$ ratio is adopted by all production units. Some authors refer to this kind of long-period equilibrium as a fully-adjusted position (Vianello, 1985, p. 70).
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Equations 1.1 to 1.4 determine the optimal K/L ratio:

\[ K/L = \left( \frac{\alpha}{\beta} \right) (r/w)^{-1} \]  \hspace{1cm} (1.6)

Eq.1.5 (the full labor employment condition) closes the model, allowing the interest rate to univocally determine demand for capital:

\[ K^* = \left( \frac{rL^{-\beta}}{\alpha A} \right)^\frac{1}{\alpha - 1} \quad \text{and} \quad \frac{\delta K^*}{\delta r} = \gamma r \left( \frac{1}{\alpha - 1} - 1 \right) \]  \hspace{1cm} (1.7)

where \( \gamma \) is a constant.\(^{10}\) Decreasing marginal productivity of capital (\( \alpha < 1 \)) is a sufficient condition for the effect of the interest rate on the optimal capital stock to be negative (\( \gamma < 0 \)), as long as \( r \) is non-negative.

Figure 1.1 illustrates an example in the K-L space with \( \alpha = \beta = 0.5 \). Imagine that initially the interest rate and wage rate are such that the optimal K/L ratio is equal to \( a \). Since \( L \) is exogenously fixed, the intersection between the vertical dotted line indicating the quantity of labour and the grey slope corresponding to the optimal K/L ratio determines a definite long-period position (point 1) with a determinate optimal capital stock (\( K_1 \)) and level of output (the isoquant \( q_1 \)). Imagine that the interest rate increases to such a level that the optimal K/L ratio decreases to \( b \). As old plants are gradually scrapped and replaced with new plants with a lower K/L ratio, the capital-intensity of the economy will gradually decrease. Eventually, all plants would adopt the new optimal K/L ratio and the economy would reach the new long-period position (point 2). During the slow transition, a cumulated flow of net (dis)investment equal to \( K_2 - K_1 \) will take place. Also aggregate output decreases.

1.2.3 Theoretical flaws of the traditional neoclassical approach

This theory of capital and investment, however, presents a major theoretical problem, related to its very conception of capital. This shortcoming has not emerged in the simple model presented above, because we have assumed an economy with only one homogeneous capital good.\(^{11}\) This assumption turns out to be crucial. In fact it has been demonstrated – mainly by the scholars that participated to the so-called ‘Cambridge capital controversy’ – that a monotonic functional relation between the optimal K/L

\(^{10}\)More precisely, \( \gamma = \frac{(\alpha A)^\frac{1}{\alpha - 1} \left( L^{-\beta} - \bar{L}^{-\beta} \right)}{\pi^{\frac{\alpha}{\alpha - 1}} - \pi^{-\beta}} \).

\(^{11}\)In our extremely simplified model, we have also assumed that this only capital good is homogeneous with output. A single capital good, distinct from the consumption good, would imply some complications but it would not undermine the possibility of deriving a neoclassical investment function. It is the presence of more than one capital good that undermines the main conclusions of the theory.
1.2. The traditional neoclassical approach

Figure 1.1: Determination of the optimal capital stock in the early marginalist approach - an example

ratio and the relative price of capital cannot be derived in an economy with several heterogeneous capital goods.

The Cambridge capital criticism We provide a more detailed exposition of this point in Appendix 1.A, while here we limit ourselves to a brief summary of the argument. In an economy with heterogeneous capital goods, the aggregate capital stock must be measured in value, given that a common physical measure is not available. But then – whatever the numeraire chosen and even in the absence of any change in production methods employed and quantities produced – the quantity of capital varies with the vector of relative prices, which in turn is a function of distributive variables. The unavoidable dependence of the aggregate value of capital upon distribution undermines the neoclassical theory of capital. In the absence of a measure of the ‘capital-intensity’ of production techniques that is independent of distribution, it is not possible to derive a decreasing demand curve for capital based on factor substitution. It has been demonstrated that the same technique can actually be cost-minimizing at two different levels of the rental cost of capital but not in between them (a phenomenon known in the literature as ‘reswitching of techniques’) and that a decrease in the interest rate may well induce profit-maximizing firms to decrease their capital intensity, however the latter is defined (a phenomenon referred to as ‘reverse capital deepening’), if the direct effect of the interest rate reduction is more than compensated by changes in the relative prices
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of the heterogeneous capital goods. The reader can find a more detailed exposition of these results in Appendix 1.A.

These findings undermine neoclassical capital theory in a fundamental sense: the very conception of capital on which the whole theoretical construct is based – capital as a single homogeneous production factor, a ‘fluid’ measured in value and adaptable to different forms – turns out to be untenable. And even when adopting this incorrect definition of capital, one finds that there is no general negative relation between the long-period \( K/L \) ratio and the interest rate.

The full-employment assumption  While the results just summarized appear largely sufficient to undermine the traditional neoclassical theory of investment, a second line of attack, independent of the first, has been recently advanced by Petri (2015). The argument aims to prove that, even accepting the (demostrably incorrect) neoclassical determination of the \( K/L \) ratio, when endogenous changes in total labor employment are taken into account, the interest rate does not suffice to determine investment. As we have already mentioned, the neoclassical ‘long-period’ capital demand function is derived by assuming equilibrium in all the other markets – most importantly, in the labor market. Total labor employment (\( L \)) is thus taken as given, determined by a labor market clearing condition. Therefore the optimal \( K/L \) ratio, determined on the basis of capital-labor substitution, is sufficient to determine the optimal capital stock. More precisely, under putty-clay technology, it is assumed that the entire quantity of labor ‘freed’ by the scrapping of old plants (call this \( \hat{L} \)), and no more than that, will be employed in newly constructed plants. Therefore, the adoption of the optimal \( K/L \) ratio in new plants implies that the level of gross investment is fully determined by the formula

\[ I = K \cdot \hat{L}. \]

Without the full employment assumption, capital-labor substitution would only determine \( K/L \), and thus \( I/\hat{L} \), but not investment, because \( \hat{L} \) would not be determined.

Petri (ibid.), however, questions the legitimacy of the full-employment assumption. The reasoning, succinctly stated, goes as follows. The labor market clearing condition is based on the decreasing demand curve for labor. In the presence of unemployment, as neoclassical theory goes, the real wage would decrease, thus increasing employment, until full-employment is restored. However the elasticity of output to demand in the various industries, allowed by some flexibility in capacity utilization and inventory ac-

12The literature on this issue is ample. The reader can refer to Samuelson (1966) and Garegnani (1990) for major overviews from two leading participants in the debate belonging to opposite sides. More pedagogical discussions can be found in Petri (2004) and Lazzarini (2011)
cumulation/depletion, implies that (1) total employment is influenced by desired output and (2) a multiplier effect is at work. Suppose that, in this context, the real wage decreases for exogenous reasons (for example a political decision to abolish minimum wage legislation). Given the initial level of output, this would decrease investment because of a reduction in the optimal $K/L$ ratio, that leads to reduced investment in new plants. But the decrease in investment would have a multiplier effect. The output level would thus be reduced, and by more than the decrease in investment. A significantly lower output level would mean that, notwithstanding the decrease in the $K/L$ ratio, total labor employment may well decrease. The sensitivity of industries’ output to demand thus undermines the decreasing demand curve for labor on which the full-employment assumption is based.

According to this reasoning, the full employment assumption should be dropped and substituted with the condition that labor employment is determined by effective demand. This would give rise to a different investment function – similar, as we will see, to the so-called ‘neoclassical accelerator’ models – in which a major influence of demand on investment is admitted.

### 1.3 The ‘array of opportunities’ approach

Some authors have proposed a different derivation of the neoclassical interest-elastic investment function, that does not rely on capital-labor substitution, but is instead based on what has been called the ‘array of opportunities’ approach.\(^{13}\)

The idea is very simple. At any given point in time, each firm is presented with several possible investment projects, which can be ranked on the basis of their expected rate of return. Profit-maximization implies that the projects offering a rate of return higher than the ongoing interest rate – and thus providing positive profits – will be undertaken.\(^{14}\)

Consider what happens if the interest rate decreases. For each firm, investment projects that were unfeasible will become profitable. Aggregate investment, defined as the sum of all investments realized in the economy, will thus increase. Figure 1.2 provides a graphical example: there are 12 potential investment projects, each defined by its expected rate of return (on the vertical axis) and its size in monetary value (on the horizontal axis). As the interest rate decreases from $i_0$ to $i_1$, the amount of investment

\(^{13}\)The term is borrowed from Witte (1963, p. 445) and used also by Ackley (1978, p. 623) and Petri (2004, p. 262). This theory can be found in various authors, starting from Fisher (1930).

\(^{14}\)In the presence of risk, the rate of return should be higher than the risk-adjusted interest rate.
undertaken increases from $I_0$ to $I_1$.

At closer scrutiny, however, the 'array-of-opportunities’ approach appears hardly defensible. Competition implies that interest rate changes are bound to cause variations in prices, modifying the expected yields of all projects and their ranking. To grasp this point, we can note that (i) the rate of return of an investment project depends crucially on the price at which the output will be sold and (ii) the interest rate enters in the determination of prices, being one of the costs of production. Specifically, a change in the interest rate will change both the ratio between the prices of different products (i.e., relative prices) and the ratio between price and wage in each sector (i.e., rates of return).

It should now be clear that a variation in the interest rate is bound to modify the returns of all projects and their ranking. It is thus incorrect to take the array of opportunities as fixed while the interest rate varies, as done in Figure 1.2.\footnote{The incorrectness of this derivation of the neoclassical investment function has been generally acknowledged also by adherents to the neoclassical school. See for example Ackley (1978, pp. 623-624) and Alchian (1955, p. 942)} But this is not all: in equilibrium competition imposes a uniform normal profit rate\footnote{The normal profit rate is defined as “the rate of return on capital which would be obtained by firms using dominant or generally accessible techniques, and producing output at levels regarded as normal at the time the capacity was installed” (Pivetti, 1991). It corresponds to the neoclassical equilibrium (or natural) rate of return on capital.} on all investments (after allowing for risk differentials), so there is no array of opportunities to start with (Ackley, 1978, p. 623). And the normal rate of return will move in step with the interest rate: because of competition, an autonomous decrease in the interest rate...
will result in a reduction in prices relative to wages, thus decreasing also the normal rate of return (Pivetti, 1991).  

\[1.4\] Jorgenson’s investment model

In a seminal article published in 1963, Jorgenson proposed a neoclassical investment model that proved extremely influential. The declared aim was “to present a theory of investment behavior based on the neoclassical theory of optimal accumulation of capital” (Jorgenson, 1963, p. 248). Jorgenson’s model has indeed gained recognition as the standard neoclassical investment model.  

In this section we provide a detailed discussion of Jorgenson’s approach, as originally presented, and as interpreted and applied in the subsequent literature. We will argue that the model is not only subject to the Cambridge capital critique, like the traditional neoclassical approach, but it also presents additional fundamental difficulties.

1.4.1 Demand for capital in Jorgenson’s model

Jorgenson (ibid.) starts with the assumption that the firm maximizes the present value of the sum of all future net revenues, taking all relevant prices (including the interest rate) as exogenous. He also assumes a two-good economy, with one (homogeneous) capital

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17 Of course the economy can be in disequilibrium in the short run. But as long as some type of investment emerges, which is expected to yield a rate of return higher than the normal profit rate, firms will rush to exploit it, until the rate of return is pushed down to its normal value (Ackley, 1978, p. 623). In this sense the ‘array of opportunities’ can perhaps be seen as one of the mechanisms that contribute to ensure a tendency toward uniformity of the rate of profit over the supply prices of the various capital goods – but hardly as the mechanism that explains the rate of aggregate investment.

18 This status is explicitly recognized, for example, in the stated motivation for the inclusion of Jorgenson’s 1963 article in the list of the Top 20 most influential papers published in the first 100 years of the *American Economic Review* (Arrow et al., 2011, pp. 4-5). Indeed influential textbooks (as Romer, 2012, pp. 406-407), literature surveys (most importantly Chirinko, 1993, p. 1878 and Caballero, 1999, p. 817), theoretical treatises (notably Dixit and Pindyck, 1994, p. 5) and empirical works (recent examples are Cummins, Hassett, and Hubbard, 1994, p. 58, Fazzari, Hubbard, and Petersen, 1988, p. 144 and Bond and Xing, 2015, p. 28), all present Jorgenson’s 1963 model as the baseline standard neoclassical investment model. Another exposition of the same model is provided in an often quoted empirical work by Hall and Jorgenson (1967). It may be worth noting, to avoid confusion, that in a different paper, also published in 1967, Jorgenson proposed a different model, with different and more restrictive assumptions (Jorgenson, 1967). It is however fair to say that Jorgenson’s 1967 model – strongly and convincingly criticized by Tobin (1967, pp.156-158) in a comment appeared in the same volume – has not received widespread acceptance, as testified by the fact that it is not discussed at all in any major recent survey or textbook, nor in most empirical and theoretical studies on investment. Indeed, as of March 25th 2016, the ‘Google Scholar’ search engine reports 2,839 academic citations for Jorgenson (1963) and 1,949 for Hall and Jorgenson (1967) (the two papers presenting the model discussed here), while Jorgenson (1967) has ‘only’ 599 academic citations. See Petri (2004, pp. 287-90) for a thorough discussion of Jorgenson (1967), which makes it clear that the latter and Jorgenson (1963) are two very different models.
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good and one output good, and a Cobb-Douglas production function. The firm’s optimal capital stock is thus found by solving the following optimization problem

$$\max_{K_t, L_t} V = \int_0^\infty e^{-rt} R(t) dt$$

with

$$R_t \equiv p Q_t - w L_t - q I_t;$$

$$Q_t = F(K_t, L_t) = AK_t^\alpha L_t^\beta$$

subject to

$$\dot{K}_t = I_t - \delta K_{t-1}$$

where $R$ are net revenues,$^{19}$ $r$ is the interest rate, $p$ is output price, $w$ is the wage rate, $q$ the price of the capital good, $Q$ the quantity of output, $L$ the quantity of labor, $\delta$ the rate of depreciation and $I$ is investment (measured in physical units of the capital good).$^{20}$

The solution is characterized by the marginal productivity conditions

$$\frac{\delta Q}{\delta L} = \frac{w}{p} \quad \text{and} \quad \frac{\delta Q}{\delta K} = \frac{q(r + \delta)}{p} = \frac{c}{p}$$

where the composite term $c = q(r + \delta)$ is labeled the ‘user cost of capital’.$^{21}$

The optimality conditions in equation 1.9 are of course analogous to equations 1.2 and 1.3 above (although in writing equations 1.2 and 1.3 we have assumed capital homogeneous to output – thus neglecting the price of capital relative to output – and no depreciation). The important difference is of economic interpretation: in the traditional theory the marginal productivity conditions apply at the level of the aggregate economy, while Jorgenson’s model takes the single (perfectly competitive) firm as its object of analysis.

The indeterminacy problem At this point, the analysis is bound to encounter a major problem. Under constant returns to scale (CRS), the optimality conditions in

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19. This specification of the net revenue (or profit) function has been criticized by Petri (2013): the investment expenditure ($I_t$) is not a reduction of profits at time $t$, but an investment financed either by an increase in debt or by the use of previously accumulated own funds. So it will affect profits from time $t + 1$ onwards, in terms of interest payments or opportunity cost of the reduction in own funds, but not those at time $t$. Accordingly, the net revenue function should include interest payments (or equivalently opportunity cost) on the existing capital stock, but not the investment expenditure. Surprisingly, the subsequent investment literature has followed this unorthodox definition of the net revenue function. (Specifically, Petri refers to the model in Romer (2012), that follows Jorgenson in using this definition of profits.)

20. With respect to the formulation reported in Jorgenson (1963), we are neglecting taxes to simplify the exposition and concentrate on the important features of the model.

21. Capital gains ($\ddot{q}$) are neglected for simplicity (here and also in Jorgenson’s analysis).
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Equation 1.9 only define the optimal $K/L$ ratio, while the optimal capital stock remains indeterminate.\footnote{With CRS, the profit function of a price-taking firm is linear in the capital stock, so the optimal value of the latter is not determined. This is a well-known problem in neoclassical production theory: under a linearly homogeneous production function, the optimal size of a price-taking firm is either zero, infinite or undefined, depending on whether the unit production cost is higher, lower or equal to the unit price of output.} We can call this the ‘indeterminacy problem’ affecting Jorgenson’s model. In order to derive a demand function for capital, some other assumption must necessarily be introduced.

As discussed in Section 1.2, traditional neoclassical analysis surmounted this problem by studying the aggregate investment market under the assumption of equilibrium in all the other markets. In particular, assuming market-clearing equilibrium in the labor market allowed early neoclassical authors to take $L$ as given. With $L$ fixed, for each given level of the cost of capital, the implied optimal $K/L$ ratio would suffice to determine the optimal capital stock. The stated aim of Jorgenson’s model, as declared in its Introduction, was to present an investment model based on the traditional neoclassical theory of demand for capital (Jorgenson, 1963, pp. 247-248). However, by taking as its object of analysis the single competitive firm instead of the aggregate capital-good market, Jorgenson’s model is bound to depart from the traditional neoclassical theory of capital. His model cannot possibly be ‘closed’ by taking labor employment as given: to the contrary a single firm operating under perfect competition is by definition able to hire any desired amount of labor at the prevailing wage rate.

Jorgenson (ibid.), instead, proposes to ‘close’ the model through the following assumption:

“[W]e assume that output and employment on the one hand and capital stock on the other are determined by a kind of iterative process. In each period, production and employment are set at the levels given by the first marginal productivity condition and the production function with capital stock fixed at its current level; demand for capital is set at the level given by the second marginal productivity condition, given output and employment. With stationary market conditions, such a process is easily seen to converge to the desired maximum of net worth. Let $K^*$ represent the desired amount of capital stock, if the production function is Cobb-Douglas with elasticity of output with respect to capital, $\alpha$,\footnote{Jorgenson denotes the elasticity of output w.r.t. capital as $\gamma$, while we have indicated it as $\alpha$ here for consistency with the previous sections.} 

$$K^* = \alpha \frac{pQ}{c}$$

(1.10)
Jorgenson thus argues that the ‘indeterminacy problem’ can be solved by simply taking the initial capital stock level as given and then assuming a trial-and-error process by the firm. He then jumps to the formulation of a capital demand function that, given technology, depends on output level and cost of capital. He does not provide a formal proof or a numerical example to illustrate the proposed ‘iterative process’ and show that it indeed yields a determinate optimal capital stock, equal to equation 1.10.

In fact, the iterative process proposed by Jorgenson does not appear convincing as a solution to the ‘indeterminacy problem’. First, note that an optimal capital stock level cannot possibly be selected by taking both output and employment as given, as Jorgenson writes in the passage above. As it is easy to see from the production function in equation 1.8, if both L and Q are taken as fixed, no change in K is possible. The only way to make some sense of the iterative process proposed by Jorgenson is thus to assume that only output (or only employment) is taken as given in the second stage of the process, so that the firm is free to vary the K/L ratio (and consequently the capital stock) on the basis of the cost of capital.\(^{24}\)

However, even after making this correction, the assumption that in the second step of the process, when choosing its optimal capital stock, the firm would take the output (or employment) level – determined in the previous period on the basis of inherited capital stock and marginal productivity conditions – as fixed, appears impossible to justify (as noted in Borch, 1963). A competitive firm can certainly adjust both its output and employment levels.\(^{25}\)

Let us accept, for the sake of argument, the questionable assumptions of this iterative

\(^{24}\)It appears plausible to conjecture that this may be what Jorgenson actually meant. In a subsequent article, published in 1972, however, he refers to the iterative process proposed in his 1963 article, quoting almost in full the same passage that we reported above, without acknowledging or correcting the mistake of taking both employment and output as given in the second passage (Jorgenson, 1972, p. 233).

\(^{25}\)Borch (1963) criticizes the iterative process proposed by Jorgenson as follows: “Professor Jorgenson’s investment theory is based on two behavioral assumptions: (1) Capital stock is taken as fixed, and the firm determines the optimal level of output. This is a very reasonable short-run assumption, (2) The output level determined under the first assumption is taken as fixed, and the optimal amount of capital stock is determined. This seems to be a rather doubtful assumption. The two assumptions together imply that investment is a trial-and-error process. Professor Jorgenson states that it is easy to see that the process will converge. However, if this is easy to see, why does not the firm see it? It seems natural to assume that intelligent management will see more than one step ahead in this process and try to optimize output level and capital stock simultaneously. This seems particularly natural under the perfect certainty assumed by Professor Jorgenson.” (p.273). Quite surprisingly, in his discussion Borch does not mention the fact that under CRS this simultaneous determination would lead to indeterminacy. Moreover, he does not note that in his article Jorgenson argues that both output and employment could be taken as given in the second step of the process.
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process, and assume that only output or employment is taken as given in the second step, to avoid immutability of the capital stock. Two questions then arise: does this process indeed converge also under CRS? is the solution to which the model iteratively converge dependent or independent of initial conditions?

It is easy to see that under decreasing returns to scale the process would converge to a solution that is independent of initial conditions, and dependent only on prices and technology. But in this case there would be little need for an iterative process to start with: the solution could be determined just on the basis of the marginal productivity conditions in equation 1.9. As Borch (ibid.) rightly asks (see note 25 above), why would the firm undertake the trial-and-error process described by Jorgenson, instead of optimizing $K$, $L$ and $Q$ simultaneously?

In the more interesting case of CRS, instead, the iterative process described by Jorgenson would generally not converge to an optimal capital stock. More precisely, with $p$ greater than unitary cost, the optimal capital stock would increase at every iteration, tending towards infinite; with $p$ equal to unitary cost, the iterative process would just bring the firm to keep $K$ at its initial level forever (so the process converges immediately, but the solution fully depends on initial conditions); with $p$ lower than unitary cost, $K$ would decrease at every iteration, tending towards 0. Unsurprisingly, the ‘iterative process’ proposed by Jorgenson reaches the same results of standard optimization, and does not resolve the indeterminacy problem.

1.4.2 Two very different solutions to the indeterminacy problem

Even though explicit evaluations are in scarce supply, the subsequent literature appears to generally acknowledge that the ‘iterative process’ proposed by Jorgenson does not solve what we called the ‘indeterminacy problem’. In his survey, indeed, Chirinko (1993) states that

“the definition of $K^*$ provided by [Jorgenson’s model] has been questioned. No problem arises if the production technology exhibits decreasing returns to scale but, when returns are constant (as assumed by Jorgenson), $K^*_t$ is not well defined” (p.1879).

So how does the large literature stimulated by Jorgenson’s investment model deal with this indeterminacy problem, if the iterative solution proposed by Jorgenson is (rightly) deemed unconvincing? It is possible to identify two different strands in the

\[\text{footnotesize}\begin{align*}
26\text{ An exception is Borch (ibid.), in the passage reported in note 25 above.} \\
27\text{ The statement that Jorgenson assumes constant returns to scale appears in fact questionable: in his 1963 article he does not make any explicit assumption regarding returns to scale. More on this later}\end{align*}\]
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One way to avoid indeterminacy is to assume decreasing returns to scale. Under decreasing returns, equalization of the cost of capital with the marginal profitability of capital identifies a unique capital stock level. The profit-maximizing levels of $K$, $Y$ and $L$ are thus simultaneously determined on the basis of factors’ prices and returns to scale.

A recent example of this approach can be found in the latest editions of Romer’s popular macroeconomics textbook. Romer’s discussion of investment theory begins by presenting a ‘baseline’ model for the determination of the optimal capital stock under perfect competition and no adjustment costs, assuming decreasing returns to scale (Romer, 2012, pp. 405-406). Another recent example, that will be discussed in some detail in Section 1.5.2, is found in Caballero and Engel (1999). An earlier influential paper that derives an optimal capital stock by assuming decreasing returns to scale is Lucas (1967, p. 80), while a statement signaling the diffusion of this approach can be found in Söderström (1976):

“*If the production function is linearly homogeneous the [equations describing the factor demand functions] cannot be solved for the optimal levels of input but only the optimal capital/labor ratio ($K/L = k$) as determined by the factor price ratio. The step from [the marginal productivity conditions] to [the factor demand functions] thus depends on the fulfillment of a second-order condition on the concavity of the maximand. Economically this condition is usually imposed either on the production function (decreasing returns to scale) or on the revenue curve (monopolistic situations).”* (p.371)

We can call the one with decreasing returns to scale the ‘most neoclassical’ version of the theory, because it implies that, given the production function, demand for capital depends only on prices, as in traditional neoclassical theory (although on the basis of different premises).

A very different solution is to take output as exogenously given – determined by aggregate demand. This solution appears inconsistent with Jorgenson’s focus on an atomistic price-taking firm, that can sell any desired amount of output at the given mar-

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28 Specifically, Romer (2012, pp. 405-406) writes profits as $\Pi(K, X_1, X_2, \ldots, X_n) - r_b K$, where $X$s are the relevant (exogenous) prices and $r_b$ is the Jorgensonian user cost of capital. $\Pi()$ is a value function that indicates the maximum profit the firm can achieve as a function of the capital stock level, taking prices as given. It is then assumed that $\Pi_{KK} < 0$. Here $\Pi_K$ is not the marginal product of capital in the traditional sense (that is, keeping the employment of other factors fixed), but the marginal contribution of an additional unit of capital, with other inputs optimally adjusted. CRS would thus imply $\Pi_{KK} = 0$, while $\Pi_{KK} < 0$, as assumed by Romer, implies decreasing returns to scale. See Pariboni (2010, pp. 83-86) for a detailed discussion of Romer’s baseline investment model, referring to an earlier edition of the textbook, that is however identical in this part.
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It is however legitimate if the representative firm is interpreted, as appears more correct, as a scale copy of the whole business sector, or equivalently a hypothetical firm that would undertake all investment in the economy. It is then natural to assume that the output level is constrained by effective aggregate demand. For example the discussion of the neoclassical investment function in the well-known textbook by Dornbusch and Fischer (1993, pp.334-335) is consistent with this ‘neoclassical accelerator’ approach (as noted by Petri, 2015, pp. 334-336).

The ‘neoclassical accelerator’ model can be illustrated graphically employing the simple model presented in Section 1.2.2. Equations 1.1 to 1.4 define also (a simplified version of) this model. However output (instead of labor employment) is taken as fixed, thus equation 1.5 is substituted with \( Q = \bar{Q} \). Rearranging yields the ‘Jorgensonian’ demand for capital function\(^{29}\) \( K^* = \alpha \bar{Q} r \). Figure 1.3 illustrates this solution (again with \( \alpha = \beta = 0.5 \)). As in the graphical exemplification of the traditional model (Figure 1.1), a given ratio of the interest rate to the wage rate determines the \( K/L \) ratio (a). But in this case \( L \) is unconstrained, while the isoquant is taken as given \( (Q = q) \) so we can determine that the economy is in point 1. In this case if the interest rate increases and lowers the optimal \( K/L \) ratio to \( b \), the economy moves along the given isoquant and reaches point 2. Notwithstanding the putty-putty technology and perfect factor substitutability, the elasticity of demand for capital with respect to the interest rate is lower than in the traditional approach. Moreover, the decrease in capital intensity is associated with an increase in employment.

The distinction between these two ways to derive the demand for capital function from the optimality conditions is crucial: it actually defines two alternative theories of the optimal capital stock. In the first, aggregate demand exerts no autonomous influence: given returns to scale, \( K^* \) depends only on the relative cost of capital. By contrast in the second approach, taking output as given, an influence of aggregate demand (the accelerator effect) is admitted.\(^{30}\)

It is not easy to assess which of these two approaches is the one actually followed by Jorgenson. The dominant interpretation in the literature appears to be that he assumes

\(^{29}\)Here the interest rate is the only component of the cost of capital, given that we are neglecting taxation and depreciation, and capital is homogeneous with output so their price is the same.

\(^{30}\)Note that virtually all empirical works estimating the neoclassical investment function either employ the composite term \( pQ \) as the independent variable (an example, besides Jorgenson, 1963 and Hall and Jorgenson, 1967, is Bernanke, 1988), or estimate separately the effects of the cost of capital and output (an example is Chirinko, Fazzari, and Meyer (1999)). In both cases output is implicitly treated as exogenous. This appears very likely to be a consequence of the universally recognized fact that output changes explains the largest fraction of investment variation in empirical data. Therefore not including it among the independent variables would result in embarrassingly low explanatory power and evident specification problems.
constant returns to scale and takes output as exogenously given, hence following the ‘neoclassical accelerator’ approach. This interpretation is not fully consistent with the way Jorgenson formulates the theory: in the iterative process that he describes, output is determined endogenously. He takes initial capital stock, technology and prices as the data of the iterative process by which the optimal capital stock is determined. And the iterative process would converge to a unique optimal capital stock, as claimed by Jorgenson, only under decreasing returns to scale. Moreover, his focus on a single atomistic competitive firm is not consistent with taking output as given.

On the other hand, however, the Jorgensonian formula determining the optimal capital stock (equation 1.10), with output on the right side of the equation, implies assuming this term to be exogenous, consistently with the ‘neoclassical accelerator’ approach. And in the empirical estimates performed in the econometric part of the 1963 article – as well as in subsequent empirical work – the composite term \( \frac{pQ}{c} \) is the independent variable, which implies considering output as exogenous.\(^{31}\) In addition to this, in a subsequent article published in 1972, Jorgenson recognizes that “failure to distinguish between the two alternative interpretations of desired capital, corresponding to constant and decreasing returns to scale, its presence in the right side of the estimated equation would result in biased estimates. Of course another large source of bias, in Jorgenson’s regressions on aggregate US manufacturing data (as in virtually all the early empirical works on the investment function), is the positive influence of investment on aggregate output. As investment positively affects the composite term \( Y/c \) (through its positive effect on \( Y \)), the estimates of the impact of changes in the term \( Y/c \) on investment will suffer from upwards bias.”

\(^{31}\)
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1.4. Jorgenson’s investment model

ing returns, has been an important source of confusion in the theory of investment” and claimed that his model “corresponds precisely to optimal production and investment policy under constant returns in production and installation” (Jorgenson, 1972, p. 233), thus corroborating the interpretation of his model as assuming constant returns – while at the same time not noticing the inconsistency between his proposed iterative process (that he stated again in this very same 1972 article) and the assumption of CRS.

In conclusion on this point, the interpretation of Jorgenson (1963) as proposing a ‘neoclassical accelerator’ model, while certainly not groundless, appears to neglect important inconsistencies. To be consistent, the ‘neoclassical accelerator’ approach must assume constant returns and interpret the representative firm as a scale copy of the business sector, not an atomistic price-taking firm. Jorgenson’s 1963 model is actually a mix of two mutually incompatible approaches: it first describes an endogenous determination of output – which can yield a definite result only under decreasing returns to scale – but then derives and estimates empirically an equation that makes sense only if output is taken as exogenously given.

1.4.3 From demand for capital to investment in the Jorgenson model

Having determined in this (ambiguous, as we have argued) fashion the optimal capital stock, Jorgenson (ibid.) deals with the problem of deriving the investment function from the capital demand function. (In section 1.2 we have seen how this problem has been addressed in the framework of traditional neoclassical theory.)

Jorgenson introduces delivery lags: new capital is not installed instantaneously. Net investment is therefore a distributed lag of new orders, which are made by firms in each period to fill the gap between the initial and the optimal capital stock. Given the assumption of ‘radioactive’ depreciation, replacement investment is proportional to the capital stock. Indicating net investment with $I_N$ and replacement investment with $I_R$, we thus have

$$I_t = I_N^t + I_R^t = \sum_{j=0}^{J} \beta_j \Delta K_{t-j}^* + \delta K_t = \sum_{j=0}^{J} \beta_j \alpha \Delta \left( \frac{PQ_{t-j}}{c_{t-j}} \right) + \delta K_t$$

(1.11)

with $\beta_s$ and $J$ depending on the speed of delivery.\(^{32}\) Given the assumption that in each period firms order the amount of capital goods that would fill the gap between actual and optimal capital stock, the theory also implies $\sum_{j=0}^{J} \beta_j = 1$.

\(^{32}\)A peculiar feature of this formulation is that delivery lags do not apply to replacement investments, but only to the share of investment that enlarges the capital stock. We neglect this problem here, to focus on more fundamental issues.
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Static expectations are implicitly assumed: the firm orders the quantity of capital goods that would make it reach the optimal capital stock, even if it knows that they will be delivered with some lags, as if it expected the optimal capital stock to remain the same in the following periods.\footnote{Alternatively, one can interpret the theory as assuming that delivery lags are unforeseen – Söderström (1976, p. 371), for example, follows this interpretation – but that would seem more far stretched.}

1.4.4 Criticisms of the Jorgensonian model

Jorgenson’s neoclassical investment model has sparked a lively debate in the aftermath of its publication. Two main issues have dominated this debate (as acknowledged in the early survey by Nerlove, 1972, p. 225): the assumption of a unitary elasticity of substitution and the determination of the ‘speed of adjustment’.

The elasticity of substitution problem First, Jorgenson has been criticized – most famously by Robert Eisner – for having assumed a Cobb-Douglas production function. This assumption results in (i) a unitary elasticity of substitution between capital and labor and (ii) a unitary negative elasticity of desired capital and investment to the cost of capital. Indeed with a more general constant-elasticity-of-substitution (CES) production function with elasticity of substitution $\sigma$, the elasticity of the optimal capital stock to the cost of capital would be $-\sigma$.\footnote{The elasticity of desired capital to the cost of capital can be written as $E_c = \delta \ln (K^*) / \delta \ln (c)$. With desired capital derived from a Cobb-Douglas and equal to equation 1.10, we have $E_c = -1$. As Jorgenson assumes that (barring delivery lags) net investment is equal to the change in demand for capital, also the elasticity of investment to the cost of capital is unitary. With a CES production function, the optimal capital stock would become $K^* = \alpha(pQ)c^{-\sigma}$, where $\sigma$ is the elasticity of substitution between capital and labor. In this case $E_c = -\sigma$, so $\sigma$ is also the absolute value of the elasticity of desired capital (and thus of investment) to the cost of capital. The elasticity to output (if the latter is assumed to be exogenous) is instead unitary in both cases, independently of the value of $\sigma$.}

Jorgenson assumed a Cobb-Douglas production function not only in his theoretical model, but also in empirical applications. In the econometric section of his influential 1963 paper, as well as in subsequent work (most importantly the empirical analysis of the influence of tax policy on investment provided in Hall and Jorgenson, 1967), he estimated equation 1.11, using the composite term $pQ$ as the independent variable and imposing the constraint $\sum_{j=0}^{J} \beta_j = 1$ (Jorgenson, 1963, p. 252).\footnote{Note that in estimating empirically equation 1.11, $\alpha$ is not known, so it is impossible to estimate empirically both $\alpha$ and the $\beta_s$. While this problem could be solved by transforming variables in natural logarithms (see note 36 below), the solution employed by Jorgenson is to estimate empirically $\alpha$ by imposing the constraint $\sum_{j=0}^{J} \beta_j = 1$.} This amounts to assume that (i) and (ii) hold.

Critics correctly argued that Jorgenson’s empirical findings, apparently favourable
to the neoclassical investment function, were likely to be highly dependent upon these assumptions. In particular, by constraining the coefficients on the cost of capital and on output to be equal and unitary, he was imposing a relevant effect of the cost of capital, rather than demonstrating it. Critics like Eisner proposed, instead, to include the cost-of-capital and output terms separately, and to not constrain their coefficients, in order to test empirically whether the elasticities to output and to the cost of capital are equal and unitary, instead of assuming it. These tests generally provided evidence of a near-unitary elasticity of investment with respect to output, and of a much lower (usually near zero and statistically insignificant) elasticity with respect to the cost of capital, therefore implying a low or null elasticity of substitution. The clearer and most forceful exposition of this critique and of these findings is provided in Eisner (1970) and Eisner and Nadiri (1968, 1970). On the basis of these findings, Eisner and his coauthors advocated the use of a more general form for the production function – CES instead of Cobb-Douglas (Eisner and Nadiri, 1970, p. 370).

This critique has been essentially empirical, centering on whether the short-run elasticity of substitution between labor and capital is high or low. As confirmed by more recent surveys (Caballero, 1999; Chirinko, 1993), today this empirical controversy is still alive, but the widely held consensus is largely favorable to Eisner’s thesis: most empirical studies have found the elasticity of investment to the user cost of capital to be rather low, implying a low elasticity of substitution. Indeed recent presentations of the

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36For example this can be done by transforming variables in logarithmic terms, thus estimating an equation of the form $\ln(I_t) = \alpha + \sum_{m=0}^{M} [\beta_m \Delta \ln(c_{t-m}) + \gamma_m \Delta \ln(Q_{t-m}) + \mu_m \Delta \ln(p_{t-m})] + \sum_{j=1}^{J} \omega_j \ln(K_{t-j}) + \epsilon_t$. The hypothesis that production can be approximated by a Cobb-Douglas could thus be tested by assessing whether $\sum \beta_i = 1$. In broad terms, this is the approach followed by Eisner and Nadiri (1968). (Today of course, as applied economists have become more attentive to endogeneity problems, also this specification would raise doubts because of the simultaneous influence of investment on output growth and on the cost of capital.)

37Of course these findings would in turn not be considered conclusive today, especially when employing aggregate data, because they are likely to suffer from simultaneity bias due to the influence of investment on output and (possibly) on the cost of capital.

38Specifically, Eisner and Nadiri (1970) claim their findings to be consistent with “the implications of a CES production functions with elasticities of substitution nearer zero than unity (...) ” (p.370).

39In his survey, Chirinko (1993, p. 1881) notes that “although (...) empirical results with versions of the Neoclassical Model differ widely, they suggest (...) that output (or sales) is clearly the dominant determinant of investment spending, with the user cost having a modest effect.”. Blanchard (1986) is even clearer: “it is well known that to get the user cost to appear at all in the investment equation, one has to display more than the usual amount of econometric ingenuity; resorting most of the time to choosing a specification that simply forces the effect to be there. Later Bernanke and Gertler (1995) confirmed that “empirical studies of supposedly interest sensitive components of aggregate spending have in fact had a great difficulty in identifying a quantitatively important effect of the neoclassical cost-of-capital variable”. Even the survey by Caballero (1999), by far the one that is most optimistic about the explanatory power of neoclassical investment theories, has to admit that “[The cost of capital] is probably not the most important explanatory variable” (ibid., p. 815). More recent studies – for example
neoclassical theory of investment (for example in the already cited survey by Caballero, 1999, p. 817) tend to use a CES production function, as advocated by Eisner, so the Jorgensonian demand for capital function is usually expressed in the more general form $K^* = \alpha(pQ)c^{-\sigma}$, where $\sigma$ is the elasticity of substitution parameter in the production function.

This critique has thus been very effective in demolishing the idea that the elasticity of substitution between capital and labor is empirically high. Most importantly, it has provided a great deal of empirical evidence showing that the influence of the cost of capital on investment is low or insignificant, while that of output is much higher. This has important implications for the influence of economic policy on investment (see for example the discussion in Fazzari, 1993). Theoretically, however, it has been a rather mild critique, that just advocates a more general form of the production function without questioning more fundamental premises of the analysis — for example the very use of an aggregate production function with some elasticity of substitution, and the conception of capital that this implies.

The ‘speed of adjustment’ problem A second widely debated issue has been the ‘speed of adjustment’ problem. This problem concerns the derivation of the investment function from the demand-for-capital function. Jorgenson assumes that adjusting the capital stock is costless (besides the cost of acquiring capital goods). He takes into account delivery lags, but assumes that firms take every change in the capital stock as permanent, so they don’t influence the optimization problem. As a result, the firm makes its choices as if adjustment was instantaneous and costless. It has been argued, however, that to explain short-run investment dynamics one needs to model not only the optimal capital stock, but also the choice of the speed at which gaps between actual and optimal capital stock are filled. In order to do this, the adjustment process must be modeled explicitly (Söderström, 1976, p. 371). This point of view had been forcefully advocated by Haavelmo (1960), who argued in an often cited passage that

“The demand for investment cannot simply be derived from the demand for capital. Demand for a finite addition to the stock of capital can lead to any rate of investment, from almost zero to infinity, depending on the additional hypothesis we introduce regarding the speed of reaction of capital-users. I think the sooner this naive, and unfounded, theory of the demand-for-investment schedule is abandoned, the sooner we shall have a chance

Sharpe and Suarez (2014) and Kothari, Lewellen, and Warner (2014) – appear to generally confirm the result of a low elasticity of investment to the cost of capital.
of making some real progress in constructing more powerful theories to deal with the capricious short-run variations in the rate of private investment.” (p.216)

Advocates of this critique have pointed out that in the Jorgensonian approach a discrete change in the data of the equilibrium would cause a discontinuous change in the desired capital stock; in the absence of frictions, firms would therefore tend to reach the new optimal capital stock instantaneously – given the assumption of putty-putty capital implicit in the model – resulting in a rate of net investment \( \dot{K} \) that tends to infinite. This critique is at the basis of all major developments of mainstream investment theory since the Seventies, which mainly consist of attempts to enrich the neoclassical framework by explicitly modeling adjustment costs – as we will discuss in Section 1.5.

Also this critique, nevertheless, however much dismissive of the Jorgenson model, does not touch its core: the Jorgensonian determination of the optimal capital stock is not questioned. The critique in fact concerns only the derivation of the short-run investment function from the long-run capital demand function. In the remainder of this section we instead discuss more fundamental critiques, that cast doubt on the Jorgensonian demand for capital function: the incorrect treatment of capital and the aggregation problem.

**Treatment of capital**  The Jorgensonian approach - just like traditional neoclassical theory - determines the optimal capital stock on the basis of a monotonic negative relation between the \( K/L \) ratio and the relative cost of capital. However, as already discussed (Section 1.2.3 and Appendix 1.A), the heterogeneity of capital goods makes it impossible to derive such a relation. This means that the use of a CES aggregate production function – as advocated by some early critics of the Jorgenson model – with capital (the homogeneous value factor) and labor as its arguments, is just as incorrect as the use of a Cobb-Douglas. The Jorgenson model, in all its versions, is thus undermined by the ‘Cambridge-criticism’.\(^{40}\)

**The aggregation problem**  Jorgenson appears to take it for granted that the aggregate demand for capital function of the economy is just a scaled-up version of that of the single firm, without mentioning the problem of aggregation. But is this assumption innocuous, or does it imply some fallacy of composition? The answer appears to be that it depends.

What we have called the ‘most neoclassical’ version of the theory, which assumes

\(^{40}\)This is pointed out for example in Petri (2004, pp. 256-291)
decreasing returns to scale, certainly suffers from a fallacy of composition. Decreasing returns to scale can determine the optimal level of output and capital for each firm but not for the whole economy, in which the number of firms is free to vary (Ackley, 1978, p. 624). At the aggregate level, the marginal productivity of capital can be decreasing only if the full employment of all other factors is assumed, as done in the traditional neoclassical approach. In fact it is not even possible to define the notion of marginal product of a production factor, without taking as fixed the quantities of all other factors employed in conjunction with it.

That undermines the main implication of this approach – that aggregate investment can be determined only on the basis of prices and technology – even without questioning the assumptions of decreasing returns to scale at the firm level and perfect substitutability. For example imagine that aggregate demand is expanding but it is not convenient for the existing price-taking firms to increase their size, because of strongly decreasing returns to scale. Other firms will be created - each one with the optimal size and K/L ratio - until the entire demand is met at cost-covering prices. So decreasing returns at the firm level will have no influence on aggregate output and on the aggregate capital stock, they will just determine the optimal size of the firm, and thus the optimal number of firms for each given level of aggregate demand. What we called the ‘most neoclassical’ approach is thus better interpreted as a theory of the optimal size of the competitive firm, rather than a theory of aggregate investment.

The fallacy of composition incurred by treatments of investment that rely on decreasing returns to scale is stated very effectively by Ackley (ibid.):

“[An] incorrect derivation [of the neoclassical investment function] rests on factors internal to a firm, which have little relevance for an economy in which the number of firms is free to vary. We assume that a firm’s long-run (as well as its short-run) production is subject to diminishing returns – either because some factor of production, perhaps the contribution of the ultimate decision maker, is fixed in amount or because of inevitable diseconomies of organization, communication, or management that arise as the scale of a firm increases. This means that any firm’s calculation of profitability must recognize that, beyond some point, additional investment implies less than proportionate increases in output and/or more than proportionate increases in employment. Thus, the [interest rate level] that will equate [the marginal profitability of capital] and [the interest rate] must decline in order for [investment] to increase. True enough. But this explains only the size of the firm, not the amount of aggregate investment. The number of firms is not
1.5 Adjustment-costs models of investment

Models with adjustment costs are nowadays the workhorse of mainstream investment theory. They are employed by virtually all of today’s advanced Macroeconomics textbooks and recently published journal articles.

The approach has been developed in response to the two issues that dominated the debate in the aftermath of Jorgenson’s seminal contribution. On the one hand, these models address the theoretical problem of how to derive a finite rate of investment when a change in the data causes a discrete change in the desired capital stock (the ‘speed of adjustment’ problem). On the other, by introducing sluggish adjustment, they attempt to reconcile neoclassical theory with the empirically observed low elasticity of investment to changes in (the neoclassical definition of) the optimal capital stock, and in particular with the weak effect of the cost of capital.

The fundamental idea is that the investment choice of a firm can be thought of as a two-stage process. First, the firm selects its optimal capital stock level ($K^*$) on the basis of the marginal productivity conditions as applying to the whole economy, due to both direct and indirect substitution mechanisms (as in the traditional neoclassical approach), and at the same time let aggregate output be determined by effective aggregate demand.

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41 Ackley (1978) makes it clear in a note that “[t]he preceding comments seem applicable to the “neoclassical” investment analyses of Jorgenson and others, who derive the specifications of an investment function from a micro-economic analysis of a profit maximizing-firm, without apparent reference to problems of aggregation” (note 15)
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of the relevant data. Second, it chooses the speed at which the gap between the current and the optimal capital stock will be closed, thus determining the rate of investment. In order for the latter choice to be meaningful (that is, to not result in instantaneous adjustment), it is assumed that there are costs associated with the alteration of the capital stock, besides the costs of purchasing capital goods. These can be due to installation costs, reorganization of the plant, retraining of workers, and so on. These costs of adjustment are assumed to be a function of the rate of investment and (possibly) of the capital stock level.\footnote{With deal here only with \textit{internal} adjustment costs, that is adjustment costs due to factors internal to the firm, while keeping fixed the supply price of capital goods. Increases in the supply price of capital goods that are due to increasing demand are instead defined as \textit{external} adjustment costs. The recent literature, however, has focused almost exclusively on internal adjustment-costs.}

Begg (1982) summarizes the reasoning as follows:

“First, we require a model determining $K^*$, the capital stock which firms currently believe they wish to hold in the long run. (...). Secondly, we require an adjustment rule or function

$$I_t = f(K^*_t - K_{t-1})$$ (1.12)

which determines the rate at which $I_t$, \textit{net} investment at time $t$, eliminates the discrepancy between $K_{t-1}$, the capital stock carried over from the end of the previous period, and $K^*_t$, the capital stock to which firms currently wish to converge.” (p.185-6)

The functional form of $f(.)$ – that is to say, the optimal path of investment – is determined by some assumption on the nature of adjustment costs. In general, convex adjustment-costs models tend to predict a smooth and gradual path of adjustment, while models with non-convex adjustment costs tend to predict 'lumpy' investment, that is periods of inertia followed by investment bursts. In the remainder of this section we provide a baseline version of these models to illustrate their main characteristics, before discussing criticisms.

1.5.1 Convex adjustment costs

The standard assumption in the literature is that adjustment-costs are convex, meaning that they are increasing at an increasing rate in $I$. For example, under this assumption, building two identical new plants costs to the firm more than twice as much as building just one. Adjustment costs are usually also assumed to be decreasing in $K$, meaning
that an investment project of a given size is relatively less costly for a big firm than for a small one. The canonical model is thus written as follows:\textsuperscript{43}

\[
\max_{K_t, L_t} V(0) = \int_0^\infty e^{-\int_0^t r_s ds} R(t) dt
\]

with

\[
R(t) \equiv Y(K_t, L_t) - G(I_t, K_t) - w_t L_t - q_t I_t;
\]

\[
G_I > 0; \quad G_{II} > 0; \quad G_K \leq 0; \quad G(0, K) = 0;
\]

subject to

\[
\dot{K} = I - \delta K; \quad \delta > 0
\]

(1.13)

where \( R \) are revenues;\textsuperscript{44} \( Y \) output; \( K \) capital, \( L \) labour, \( w \) the real wage; \( q \) the relative price of capital; \( G \) adjustment costs; \( \delta \) the depreciation rate and \( r \) the interest rate. As usual in neoclassical models, capital is assumed to be a single homogeneous factor. Output price is taken as a numeraire and adjustment costs are expressed in terms of units of output.

It should be clear that without adjustment costs the model would be practically equivalent to the Jorgensonian formulation, thus yielding the conditions in equation 1.9. With adjustment costs, instead, the first order conditions for an optimum imply

\[
\lambda_t = q_t + G_I; \quad \lambda_t = \frac{Y_K - G_K}{r + \delta} + \dot{\lambda}
\]

(1.14)

Where \( \lambda \) is the shadow price of capital, or marginal profitability of capital. This is defined as the increase in net revenues that would be provided by an additional unit of capital, after other inputs have been optimally adjusted.\textsuperscript{45} The economic interpretation of this condition is that the profit-maximizing investment rate equates the marginal profitability of capital with its marginal cost. The marginal cost is comprehensive not only of the price of buying an additional unit of capital, but also of the increase in adjustment costs that its installation would generate. The marginal profitability of capital, in turn, depends on its marginal productivity, the depreciation rate, the effect of a greater capital stock on adjustment costs, the rate at which future profits are discounted, and the capital gains it will provide.

Given the assumed convex shape of \( G(\cdot) \), the adjustment-costs function, equation

\textsuperscript{43}A formalization practically equivalent to this one is found, for example, in the influential article by Hayashi (1982).

\textsuperscript{44}This specification of revenues suffers from the same problem discussed in note 19, however it is (quite surprisingly) the most common in the literature.

\textsuperscript{45}Note that the shadow price of capital is thus different from the marginal product, because the latter is defined by taking the employment of other factors as fixed. The shadow price of a good is also generally defined as the maximum number of units of account that the optimizing agent is willing to pay for one additional unit of the good.
1.14 implicitly defines the following investment function

\[ I = F(\lambda, q, K) \quad \text{with} \quad F_\lambda > 0; \quad F_K \geq 0; \quad F_q < 0 \quad (1.15) \]

This is the general result of models with convex and symmetric\(^{46}\) adjustment costs: investment is increasing in the marginal profitability of capital and in the capital stock and decreasing in the relative price of capital.\(^{47}\)

Two points are worth stressing, from the perspective of this critical survey. First, unlike Jorgensonian models, convex adjustment-costs models yield definite results also under CRS, and without assuming a given level of output or labor employment. This is likely to have contributed significantly to the popularity of these models: as we have seen, the result of indeterminacy of the optimal capital stock under CRS was rightly considered as an embarrassing property of the Jorgensonian neoclassical investment model. In this sense, in view of our discussion in Section 1.4.2, we can interpret the assumption of convex adjustment costs as a \textit{third} alternative solution to the problem of indeterminacy. This solution can be seen as somehow similar in nature to the assumption of decreasing returns to scale (although certainly more refined) in the sense that it relies on factors internal to the firm, that impose some cost of expansion. The difference is that, while decreasing returns to scale allow to determine an optimal capital stock level, convex adjustment costs allow to determine an optimal rate of expansion.

Second, this model implies a negative elasticity of investment to the interest rate – a fundamental relation for neoclassical macroeconomics – \textit{even in the absence of marginalist factor substitution mechanisms}. As apparent from equation 1.14, a lower interest rate increases the net revenue per unit of capital, resulting in a faster optimal speed of adjustment and therefore a higher investment rate. That means that a lower interest rate would increase the optimal investment rate also with a fixed-coefficients production process. We postpone to Section 1.5.3 a discussion of the important objections that this derivation raises.

\(^{46}\)By symmetric here it is meant that, keeping everything else fixed, the adjustment cost of increasing the capital stock by some amount is equal to the adjustment cost of decreasing it by the same quantity.

\(^{47}\)Imposing additional (more restrictive) assumptions regarding the revenue function, the adjustment cost function and the efficiency of information-gathering in financial markets, the model can be shown to imply the relation proposed on the basis of intuitive arguments in Tobin and Brainard (1977) between stock market valuations and investment. In particular, indicating the stock market valuation of the firm as \(V\) and defining Tobin’s \(q\) as \(q = V/pK\), it can be shown that investment is a (positive) function of Tobin’s \(q\) only (Hayashi, 1982). It is however more useful, for the purposes of this essay, to stick to the more general model.
1.5.2 Non-convex adjustment costs

It has been argued that the assumption of convex adjustment costs is unlikely to hold for most firms (Hamermesh and Pfann, 1996) and indeed microeconometric studies have pointed to a complex mix of convex and non-convex elements (Russell and Haltiwanger, 2006). Therefore, while it appears fair to say that the most popular and widely adopted model remains that with convex adjustment costs, several authors have argued that non-convexities and irreversibility play an important role in influencing investment choices and have thus proposed models with non-convex adjustment costs (Caballero, 1999; Caballero and Engel, 1999; Dixit and Pindyck, 1994; Russell and Haltiwanger, 2006).

A survey of the alternative shapes of the adjustment-costs function that have been explored in the literature would be outside the scope of this paper (the interested reader can refer to Caballero, 1999; Hamermesh and Pfann, 1996; Russell and Haltiwanger, 2006). We will focus, instead, on the development which has attracted more attention in the last decade. This is a generalization of the so-called (S,s) approach, which assumes the existence of a fixed cost of adjustment. This model is broad enough to be apt to illustrate the general characteristics of non-convex adjustment-costs models.

It is assumed that there is some fixed cost that firms incur every time they alter their capital stock. The size of this fixed adjustment cost is assumed to vary randomly across firms and in time. The ‘frictionless’ optimal capital stock is defined as the capital stock level that would maximize profits in the absence of adjustment costs. The intuition is that the larger the gap between the actual and the frictionless optimal capital stock, the greater the probability that the gain from adjustment outweighs the (random) fixed cost of adjustment. The probability that a firm resizes its capital stock is thus increasing in the gap between the actual and the ‘frictionless’ optimal capital stock.

Of course the problem of deriving the frictionless optimal capital stock is exactly equivalent to that of deriving demand for capital in Jorgenson’s neoclassical model. It thus incurs in the same difficulty: the firm’s ‘frictionless’ optimal capital stock is indeterminate under constant returns to scale. To avoid indeterminacy, the proponents of this model assume ‘decreasing marginal profitability of capital’. The marginal profitability of capital is defined here as the marginal net revenue from an additional unit of capital.

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48It should be noted that ‘adjustment costs’ are multiform and rather broadly defined, therefore practically impossible to observe and measure directly. Empirical studies have tried to assess them indirectly, mainly by estimating adjustment-costs models derived under different assumptions, and testing which ones work better in predicting firms’ investment dynamics, given some (assumed) definition of the optimal capital stock (Russell and Haltiwanger, 2006, p. 611)

49Specifically, we follow the model proposed in Caballero and Engel (1999), providing a simplified version similar to the one found in Caballero (1999).
allowing the quantities of other inputs to be optimally adjusted, but not taking adjustment costs into account. The authors motivate this assumption as “due to decreasing returns in the technology or the presence of some degree of monopoly power” (Caballero and Engel, 1999, p. 787). However the model is difficult to reconcile with imperfect competition, given that the firm is assumed to be a price-taker, so it must probably be interpreted as assuming decreasing returns to scale – thus following what we have called the ‘most neoclassical’ solution to the problem of indeterminacy of the optimal capital stock.

Formally, the deviation from the frictionless optimal capital stock (the imbalance) is defined as
\[ z_{it} = \ln(K_{it}) - \ln(K^\star_{it}) \]. The stochastic fixed cost of adjustment is \( \omega \). The probability that a firm adjusts, given its imbalance and the adjustment cost it faces, is the adjustment hazard function, generally defined as
\[ \Lambda = \Lambda(z, \omega) \] with \( \Lambda_z > 0; \Lambda_\omega < 0 \) (1.16)

In the simple case in which adjustment costs are only fixed,\(^{50}\) if the firm adjusts it does so fully, reaching instantaneously its optimal capital stock (an ‘all-or-nothing’ investment policy). The expected investment rate of a firm is thus equal to its imbalance times the probability of adjustment (the hazard)
\[ E(I_{it}/K_{it}|z) = -z \Lambda(z) \] (1.17)

In order to infer aggregate investment dynamics from this microeconomic model, it is assumed that the number of firms is large but fixed, so the law of large numbers can be applied. \( \Lambda(z) \) is then interpreted as the share of firms with imbalance equal to \( z \) that will adjust, given the distribution function of \( \omega \). Aggregate investment is the integral of \( \Lambda(z) \) over the cross-sectional distribution of \( z \).
\[ I_t/K_t = -\int_{-\infty}^{\infty} z\Lambda(z)f(z,t)dz \] (1.18)

where \( f(z,t) \) is the distribution of \( z \) across firms at time \( t \). Intuitively, aggregate investment in the fixed set of firms is the sum of the expected adjustment of each firm.

The appeal of this approach mainly derives from its ability to rationalize the ‘lumpy’ investment dynamics usually observed in manufacturing plants – meaning that productive plants tend to undergo infrequent but sizable waves of investment (Doms and Dunne, 2000). See Caballero and Engel (1999) for the more nuanced version of the model, with both fixed and variable adjustment costs.
1.5. Adjustment-costs models of investment

1998). The model is in this sense more consistent with the evidence with respect to the canonical convex adjustment-costs model, that would predict a gradual and smooth investment path.

1.5.3 Can adjustment costs explain aggregate investment?

The idea that some broadly defined costs of adjustment exist at the plant level – probably a mix of fixed and variable elements – is certainly plausible. This is a realistic assumption for the microeconomic analysis of firms’ behavior in the short-run. What is less clear is whether adjustment-costs models provide new relevant insights for the theory of aggregate investment. In these respect, the theory seems to suffer from some major shortcomings.

Fallacy of composition It is generally acknowledged in the literature that non-convex adjustment costs can produce lumpy investment at the firm level without relevant implications for aggregate investment, because in the aggregate their effect is likely to ‘smooth out’.

But the problem is, in fact, much more general than this: all formulations that apply the firm’s investment function derived on the basis of adjustment costs to the whole economy suffer from a fallacy of composition. This is the same fallacy incurred by models that derive the aggregate investment function from the microeconomic analysis of a representative firm with decreasing returns to scale, discussed in Section 1.4.4 above.

This criticism is indeed not new: in his early survey, Söderström (1976, p. 386) reluctantly admitted that in models based on adjustment costs “market equilibrium (...) may be indeterminate under free entry”. Indeed the equilibrium rate of aggregate investment is left indeterminate by adjustment costs models, the moment the possibility of free entry is admitted: these models determine the optimal rate of expansion of the firm, but not the equilibrium number of firms in the economy or in an industry (Petri, 2004, pp. 279-280).

The issue is generally ignored in the recent mainstream literature: the accepted convention is to circumvent the problem by assuming that the economy consists of a fixed set of firms, without providing a rationale for this assumption nor acknowledging the problem. In fact, it appears difficult to justify ruling out entry in models of aggregate investment.

51 See for example Thomas (2002), Khan and Thomas (2008) and Hall (2004). However Bachmann, Caballero, and Engel (2006) argue the contrary
Neglected dependence of prices from the interest rate Another major criticism concerns the way in which adjustment-costs models derive a negative relation between investment and the interest rate. In models with convex adjustment costs, this relation is inferred from the optimality condition in equation 1.14. This condition states that the firm increases its investment rate until the marginal cost of capital (equal to the sum of the unit price of capital plus the marginal cost of adjustment) equals the marginal profitability of capital (defined as the present value of the increase in future net revenues that an additional unit of capital would provide). It is thus inferred that a decrease in the interest rate, keeping all other prices fixed, would raise the optimal investment rate by shifting upwards the shadow price of capital ($\lambda$) curve.

This derivation, however, contradicts basic microeconomics principles: one cannot vary the interest rate while keeping all relative prices fixed. (This is of course the same mistake incurred by the so-called ‘array-of-opportunities’ approach discussed in Section 1.3.) The interest rate on employed capital is a component of average costs. Assuming that the relation between output and input prices remains unchanged in the aftermath of an interest rate reduction, is tantamount to assuming that extra-profits can be earned over an infinite time-horizon. Clearly, the rate of return on capital is bound to move in step with the interest rate, especially in models that assume firms to be competitive price-takers.52

The illusion of precision There is also a further, more general, aspect that appears questionable. The actual patterns of adjustment costs are likely to be irregular, specific to circumstances, and thus different in each firm and for each investment project. And there is no way to directly measure them empirically, to assess if there really is some stable relation between the marginal cost of adjustment and the investment rate. It thus appears pretentious to try to identify a ‘universal’ stylized pattern of adjustment costs, appropriate for all firms at all times. It would appear more reasonable to focus on understanding the factors that make the aggregate capital stock tend to expand or contract, rather than aspire to predict precisely how each single firm will act in the very short run. In other words, adjustment-costs models are likely to be ‘precisely wrong’, while arguably it would be better for theory to get right the determination of broad

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52: This particular mistake is not incurred by the generalized (S,s) model. In this model a lower cost of capital increases investment by raising the ‘frictionless’ optimal capital stock. The latter, in turn, is identified by equating the marginal return on capital with its price, under the assumption of decreasing returns to scale. In these models, therefore, the interest-elastic investment function depends entirely on the assumption of decreasing returns to scale and no entry. When entry is admitted neither the optimal capital stock nor the optimal rate of investment are determined.
1.6 Concluding Remarks

In this essay we have reviewed the neoclassical determination of aggregate investment and its criticisms, distinguishing between the theory of the optimal capital stock (as conceived by traditional theory and later by Jorgensonian models) and that of the short-run frictions which are thought to govern the adjustment process. As we have shown, mainstream investment theory is far from bulletproof.

The traditional ‘Wickellian’ investment function rests on factor substitution mechanisms, that have been undermined by the results of the Cambridge capital controversies (illustrated in Appendix 1.A below). These have demonstrated that the neoclassical determination of the optimal capital stock can only hold in a one-capital-good economy; it falls apart when the presence of more than one capital good is admitted. The traditional approach also relies on the ‘pre-Keynesian’ assumption of continuous full-employment equilibrium in the labor market.

The modern ‘Jorgensonian’ approach to the determination of the optimal capital stock is equally based on factor substitution mechanisms, but it models the behavior of an atomistic price-taking representative firm. This model appears even less solid: not only it is subject to the Cambridge capital critique, but notwithstanding its strong assumptions it is incapable of determining the optimal capital stock in the standard setting of constant returns to scale (CRS). Specifically, even accepting the logic of the theory, under CRS only the optimal \( \frac{K}{L} \) ratio is determined, while demand for capital is not.

As we have shown, it is fundamental to distinguish between two distinct ways in which neoclassical theorists have solved this indeterminacy problem. The ‘most neoclassical’ solution is to assume decreasing returns to scale. This formulation determines investment only on the basis of relative prices and technology. It represents, however, a clear example of a fallacy of composition: when the firm’s investment function is based on a factor internal to the firm (decreasing returns to scale), it cannot be generalized to the whole economy, in which new firms can enter. The ‘least neoclassical’ solution to the indeterminacy problem is to take aggregate output as given, as in the ‘neoclassical accelerator’ model. Importantly, in this way an influence of aggregate demand on investment – the accelerator principle – is admitted.

Notwithstanding major unresolved problems, mainstream theory has evolved in the last decades as if the problem of the determination of the optimal capital stock was
solved, and it only remained to study the adjustment process toward equilibrium, by modelling the frictions caused by adjustment costs. It is natural to interpret adjustment-costs as another way to solve the problem of indeterminacy, more refined with respect to the assumption of decreasing returns to scale. The fallacy of composition remains the same: adjustment-costs models of investment cannot determine aggregate investment, even if we accept all their assumptions, because the number of firms in the economy remains indeterminate.

Ultimately, the neoclassical theory of investment appears deeply unsatisfying because it studies investment behaviour as it were a choice-of-technique problem. This is profoundly misleading. It fails to take into account two fundamental functions of capital accumulation: expanding productive capacity to meet increasing demand, and incorporating discontinuous innovations which increase production efficiency and/or open up new markets, independently of the evolution of the cost of capital (which, as the Cambridge controversy revealed, bears no necessary relation with the optimal K/L ratio). There is certainly space for developing better alternatives.

A different vision may start from the idea that firms tend to exploit all investment opportunities that are expected to yield at least the normal profit rate. But the actual rate of return expected on a given investment project will be either the normal profit rate, if outlets can be found for its entire produce at production prices, or less than the normal profit rate, if demand is not expected to absorb the produce. In this framework, aggregate net investment will be driven by expected demand, which determines the number and size of investment projects whose produce can be entirely sold at cost-covering prices. This vision of investment as entirely induced by demand growth is still incomplete, because it doesn’t include the important roles of innovation, institutional and political factors, imperfect competition. However it appears to represent the best starting point for a more convincing, non-neoclassical, theory of aggregate investment – not least because it has plenty of empirical evidence on its side.

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53 Defined as the cost-covering prices (or normal prices), with production costs including also the normal profit rate over capital goods.
Appendix

1.A The Cambridge capital controversy and the relation between distribution and the choice of technique

In this appendix we provide a simple exposition of the theoretical problems of early marginalist investment theory – in particular the impossibility of deriving a monotonic functional relation between the optimal K/L ratio and the relative price of capital when there is more than one capital good. This critique of the marginalist determination of demand for capital was brought up during the so-called Cambridge-capital controversy, mainly by economists working at Cambridge, UK.

In this exposition we take quantities produced as given, assume that no scarce resources enter production, no joint production is undertaken and the non-substitution theorem applies. Hence in the long-period prices converge, due to competitive pressure, to minimum average costs. Long-period prices can thus be determined as functions of the rate of interest, according to the system of equations

\[ \mathbf{p} = \mathbf{p}(\mathbf{d} + r\mathbf{I})\mathbf{A}(r) + w\mathbf{l}(r) \]  

(1.19)

where \( \mathbf{p} \) is the (row) vector of product prices; \( \mathbf{A} \) is the matrix of technical coefficients of non-labor inputs, \( r \) the rate of interest (here identical with the rate of profit), \( \mathbf{I} \) the identity matrix, \( \mathbf{d} \) a diagonal matrix which has the vector of input depreciation rates as its diagonal (depreciation is assumed to be of the ‘radioactive’ type), \( \mathbf{l} \) the vector of technical coefficients of labor input and \( w \) the wage rate.

54 Obviously, I claim no originality at all for this appendix: the results summarized here are well-known.  
55 The restrictiveness of these assumptions – and of the ones that will be introduced later – is not a problem here, because our aim is to show an internal inconsistency in the neoclassical determination of the optimal K/L ratio. If this can be shown in the simplest setting, it will apply also to more nuanced models.
1.A.1 Dependence of the quantity of capital on distribution

The quantity of capital in the economy is an aggregate measure of the several existing capital goods. As these different capital goods are physically heterogeneous, this aggregate measure cannot be expressed in physical quantities. It must be expressed in value. But then – as shown by the seminal contribution of Sraffa (1960) – independently of whatever numeraire is chosen, the value of the aggregate capital stock depends on distributive variables.

A simple representation of this result is found in the Sraffian literature (for example Petri (2004, pp. 208-210)). Consider the simplest case in which technical coefficients are taken as given (only one technique of production is available for each production process) and all capital is circulating ($d = 1$), so the price equations in eq.1.19 become

$$p = [1 + r] pA + w1$$

The economy-wide net product is taken as a numeraire ($py = 1$, with $y$ representing the vector of quantities produced and $p$ the vector of prices). Furthermore, measure labor input in such a way that total labour employment $L$ is $L = 1$ (total labor employment is exogenously determined, because we are taking technical coefficients and quantities produced as given).

Consider the system of price equations (eq. 1.20). The vector of prices $p$ and the wage rate $w$ can be determined on the basis of the interest rate $r$ and – due to the Perron-Frobenius theorem for non-negative matrices – a wage curve $w(r)$ exists, is downward-sloping and crosses both axes in the positive orthant of the $w$-$r$ space. We thus have a decreasing wage curve, as in Figure 1.4. Given our assumptions and choice of numeraire, the wage rate equals both the total wage bill and the wage share. The two intercepts of the wage curve represent the extreme cases in which all income goes to labor (intercept with vertical axis: $r = 0 \Rightarrow w = 1$) or to capital (intercept with horizontal axis: $w = 0 \Rightarrow r = 1$).

We thus have the income identity $p(r)y = 1 = rk + w(r)$ and we can write $k$ as a
function of the interest rate as follows

\[ k = k(r) = \frac{1 - w(r)}{r} \]  \hspace{1cm} (1.21)

Meaning that the value of capital is equal to the ratio between the sine and the cosine – and thus the tangent – of angle \( \theta \) in Figure 1.4. It is thus clear that the value of capital is a function of the interest rate.

1.A.2 Inversion in relative price movements

As already mentioned, given the price system in eq.1.20, the vector of relative prices and the wage rate can be determined as functions of the interest rate. An important result demonstrated by Sraffa (1960) is that the price of a commodity in terms of another commodity need not be a monotonic function of the interest rate. To accomplish this, he first demonstrated that in a system like eq.1.19 the price of a commodity can be determined by ‘reduction to dated quantity of wages’. This means that the price of a commodity can be calculated as an infinite series: the remuneration of the quantity of labor directly employed in the production of the given commodity, plus the (discounted) remuneration of the direct labor necessary to produce the inputs, plus the (twice discounted) remuneration of the direct labor necessary to produce the inputs to these inputs, and so on, in an infinite regress.

Formally, this can be proved by applying the Perron-Frobenius theorem, which implies that the following equality holds

\[ [I - (1 + r)A]^{-1} = I + (1 + r)A + (1 + r)^2A^2 + (1 + r)^3A^3 + ... \]  \hspace{1cm} (1.22)
We can rewrite the price equations in eq.1.20 as \( p = w\ell[I - (1 + r)A]^{-1} \) and then apply eq.1.22 to obtain

\[
p = w\ell[I + (1 + r)A + (1 + r)^2A^2 + (1 + r)^3A^3 + ...]
\]  

(1.23)

Let us now introduce the notation \( L_{i(t)} \) to indicate the dated quantities of labor that must be applied at each time period \( T - t \), for the production process of a good \( i \) to happen at time \( T \). \( L_{i(0)} \) is thus the quantity of labor directly applied in the production process that generates good \( i \) at time \( T \); \( L_{i(1)} \) is the quantity of labor directly applied at time \( T - 1 \) in the production processes that will produce the intermediate goods that are necessary to produce \( i \); \( L_{i(2)} \) is the quantity of labor directly applied at time \( T - 2 \) to produce the means of production that at period \( T - 1 \) are employed to produce the inputs necessary to produce \( i \), and so on. And of course we will have \( L_{i(0)} = \ell; L_{i(1)} = \ell A; L_{i(2)} = \ell A^2; L_{i(3)} = \ell A^3, ... \) and in general \( L_{i(t)} = \ell A^t \). Applying this notation to eq.1.23, we can express the price of a commodity as an infinite series of discounted dated wages

\[
p_i = wL_{i(0)} + wL_{i(1)}(1 + r) + wL_{i(2)}(1 + r)^2 + wL_{i(3)}(1 + r)^3 + ...
\]  

(1.24)

Sraffa (1960, p. 37) provides the example of two commodities – ‘a’ and ‘b’ – which differ in three of their ‘dated labour’ terms, all the others being equal. In other words, the series of dated wage payments determining the prices of \( a \) and \( b \) are identical, except for three terms. Commodity ‘a’ implies a greater number of work hours by 20 units at time \( T - 8 \), while commodity ‘b’ necessitates 19 more work hours at the time of production \( T \) and 1 more unit applied 25 years earlier. (Sraffa notes that this can resemble the classical example of ‘wine aged in the cellar’ and of ‘old oak made into a chest’.) The difference between the prices of these two commodities is thus equal to

\[
p_a - p_b = 20w(1 + r)^8 - [19w + w(1 + r)^{25}]
\]  

(1.25)

Sraffa takes the ‘Standard Commodity’ as the numeraire.\(^{60}\) This implies that the wage-curve is linear and equal to \( w = 1 - \frac{r}{R} \), where \( R \) is the maximum rate of profit.

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\(^{60}\) Given a certain economy (defined by its price equations), the Standard Commodity is a composite commodity, constructed in such a way that if the net product of an economy was constituted by the Standard Commodity, the set of non-wage inputs necessary for its production would represent exactly the same composition. Sraffa takes as the unit of measure of the Standard Commodity the quantity of it whose production would necessitate the same quantity of labor (per period) employed by the economy under study (Sraffa, 1960, pp.18-25).
1.A.3 Reswitching of techniques

The result just presented undermines the mechanisms of factor substitution on which the neoclassical capital demand function is based (discussed in Sec.1.2.1 of this chapter). Indirect substitution predicts that the composition of demand would shift towards more capital intensive goods as the interest rate decreases. It thus needs a purely technical
measure of capital intensity, independent of distribution. But the latter, as the example above demonstrates, does not in fact exist. If some arbitrary criterion is adopted to establish that commodity \( a \) or commodity \( b \) is more capital-intensive irrespective of distribution, we will have the paradoxical (from the point of view of neoclassical theory) result that, in some relevant ranges, increases in the cost of capital will reduce the price of the more capital intensive technique, thus increasing demand for capital.

By interpreting ‘\( a \)’ and ‘\( b \)’ as two alternative techniques for producing the same commodity, instead of two different commodities, it is possible to show that also the mechanism of direct substitution is based on shaky theoretical foundations. \( p_a \) and \( p_b \) are thus now interpreted as the unitary costs of production of \( a \) and \( b \), and of course cost-minimizing firms will adopt the technique with lower \( p \). Following Petri (2004, pp. 214-218), the point can be shown very simply by modifying Sraffa’s example in such a way that the \( p_a - p_b \) curve (eq.1.25 and Fig.1.5) is shifted downwards by some small amount. (This can be done by simply assuming uniformly smaller production coefficients for commodity \( a \) – see ibid., p. 215). The point of this modification is to yield an example in which the \( p_a - p_b \) curve crosses twice the horizontal axis, as in Figure 1.6, thus showing how is it possible for a technique to be cost-minimizing at relatively low and high values of the interest rate, but not at intermediate values. This phenomenon is known in the literature as reswitching of techniques. Besides the one that we just considered (taken from Petri (ibid., p. 215)), other numerical examples of reswitching have been presented for example by Samuelson (1966) and Pasinetti (1966). Notably, Han and Schefold (2006) provide empirical (as opposed to theoretical) examples of reswitching, using the OECD input-output tables dataset.

1.A.4 Reverse capital deepening

Reverse capital deepening occurs when a rise in the interest rate leads to an increase in the ratio of aggregate capital (measured in value)\(^{61}\) to total labor employment. It is straightforward to see that reswitching of techniques leads to reverse capital deepening. Consider the example with one commodity and two available techniques (\( a \) and \( b \)) presented in the previous section and depicted in Figure 1.6. The corresponding wage curves associated with the two techniques are displayed in Figure 1.7. For each given level of the interest rate, the cost-minimizing technique is the one associated with the

\(^{61}\) Of course the discussion in the preceding sections implies that the conception of capital as a single factor measurable in value independently of distribution is flawed. In this section we adopt this mistaken definition only to show that it brings to results that run counter to neoclassical capital theory.
most external wage curve, i.e., the one that lies on the outer envelope. Again we see that technique \(a\) is more profitable at low and high levels of the interest rate, but not at ‘intermediate’ values. Recall from Sec. 1.A.1 (in particular Fig.1.4) that the value of capital can be inferred from the prevailing wage curve. We can thus appreciate the evolution of the value of capital per worker as a function of the interest rate in this example. This is depicted in Figure 1.8. A discrete increase in the interest rate from (for example) 1% to 4% would have in this case the effect predicted by neoclassical theory: capital intensity would decrease; however a further interest rate increase, for example from 4% to 10% (of from 10% to 15%, or from 15% to 20%), would cause an increase in capital intensity.

But while reswitching of techniques is a sufficient condition for reverse capital deepening, it is not a necessary one. Reverse capital deepening can occur also in the absence of reswitching. A trivial (but possibly empirically relevant) case is the following. Imagine that the same technique is cost-minimizing for all relevant values of the interest rate. This is equivalent to (but more general than) the case in which only one production technique is available. Suppose, furthermore, that the wage curve generated by this production method is concave, like the wage curve associated with technique \(b\) in Figure 1.7. The corresponding relation between the interest rate and the value of capital per worker will be monotonically increasing, like in the segment of Figure 1.8 in which technique \(b\) remains dominant. This is due to the so-called price Wicksell effects: in the absence of any switch of technique, the aggregate value of capital is altered by the price changes caused by interest rate variations. Note that also in the presence of multiple switches of techniques that are all well-behaved from a neoclassical point of view (that is, interest rate increases are always associated with switches toward less capital intensive techniques), positive price Wicksell effects may still dominate them and produce a non-neoclassical demand curve for aggregate capital.

In addition to the cases just discussed, based on price Wicksell effects, reverse capital deepening in the absence of reswitching can be also be caused by technique switches that run counter to marginalist theory. This can happen when there are more than two available techniques. Then it is possible that two techniques cross more than once, but only one of the switches is on the outer envelope. In this case we would have reverse capital deepening whenever there is a switch between two techniques whose wage curves have

\[ k = \frac{(y - w)}{r}. \]

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62 This is a well-known result, which demonstration can be found for example in Kurz and Salvadori (1997).

63 Note that in this case, with different wage curves compared in the same diagram, we do not set the intercept of both wage curves at \(w = y = 1\): the real wage associated with \(r = 0\) (that is, \(y\)) is different for the two techniques. So the formula determining the value of capital is, more generally, \(k = \frac{(y - w)}{r}\).
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Figure 1.6: Difference between the unit production cost of techniques $a$ and $b$ as a function of the interest rate

Figure 1.7: Reswitching between techniques $a$ and $b$ in terms of wage curves

Figure 1.8: Capital intensity as a function on the interest rate, resulting from reswitching between production techniques $a$ and $b$

Source: Our own elaboration on Petri (2004, pp. 215-217) (Sraffa example modified to yield reswitching)
already crossed at a lower interest rate. And whenever this first intersection between
the two wage curves is situated below the outer envelope (while the second, at a higher
interest rate, is on the outer envelope) reverse capital deepening happens in the absence
of reswitching.

The bottom line is that capital, defined as the set of all commodities that are em-
ployed as means of production, cannot be conceived as a single homogeneous factor, that
will be employed more intensively in production whenever its price decreases. Capital
cannot be conceived as a single homogeneous factor because there is no way to measure
its quantity in ‘technical’ units – that is, independently of distributive variables. And
even if that erroneous conception of capital is adopted, there is no guarantee that the
resulting demand curve for capital is monotonically decreasing in the interest rate.
Chapter 2

Political shocks and business investment:
regression-discontinuity evidence from OECD elections

2.1 Introduction

In 1981, the year in which François Mitterrand was elected as the 21st President and a Left coalition gained an outright majority in the Assemblée Nationale, business investment fell sharply in France (Figure 2.1). Many observers argued that the left-wing political platform of the winning coalition – including widespread nationalizations, higher minimum wage, wealth taxes and substantial expansion of workers’ rights – had prompted a crisis of business’ confidence, halting capital accumulation.1 As a matter of fact, business investment recovered only in 1983-1984, after Mitterrand made his famous U-turn, completely reversing his initial economic policy.

France’s 1981 election was not a completely isolated case. In several other instances capitalists were suspected of reacting adversely to a government they did not like. Al-

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1See for example Lewis (1983), Benedetti (1982) and Sachs and Wyplosz (1986). The latter note that the 1981-1982 fall in business investment is difficult to explain on the basis of traditional investment models and thus wonder whether “[...] the mere election of a Socialist government, committed to sweeping social changes and income redistribution, prompted a crisis of business confidence among investors” (ibid., p. 277). Interestingly, this interpretation is apparently endorsed by the then French Finance Minister, Jacques Delors, who later argued that “[...] business leaders did not like this change of government. And when there is no confidence, there is no investment” (Halimi, 2007, my translation).
lende’s cabinet in Chile is another classical example – and a dramatic one – of a left-wing government which faced a strong negative reaction in terms of capital flights and falling private investment (Alaluf, 1971). But even in the US, where arguably no major political party is historically hostile to capital, Roosevelt’s attorney general Robert Jackson went as far as to denounce that the 1937 investment slump was the result of an intentional ‘capital strike’ against the New Deal, in his words “a strike against the government - a strike to coerce political action” (Jackson, 1938).

The hypothesis that entrepreneurs would tend to reduce investment when faced with institutional changes that reduce their social and economic power and their control over the workforce has long been on the table (Bowles and Gintis, 1986, pp. 88-89; Przeworski and Wallerstein, 1988), however no systematic empirical work has been presented, besides anecdotal evidence from single episodes.

In this paper we look at the behavior of business investment in the aftermath of 215 general elections in 14 OECD countries in the period 1960-2013. Specifically, our main outcome variable of interest is business investment growth in the eight quarters following an election. We employ state-of-the-art estimates of parties’ policy positions, as provided by Lowe et al. (2011), to identify a subsample of 107 elections in which the Left’s proposed economic policy was relatively more radical in terms of state intervention in the economy. We use the remaining 108 elections, in which the main left party was more ‘neoliberal’, as a sort of control group.

In order to address the simultaneity bias arising from the influence of macroeconomic factors on electoral outcomes, we employ a Regression Discontinuity (RD) design (Hahn, Todd, and Van Der Klaauw, 2001; Imbens and Lemieux, 2008). We exploit the fact that when a political side controls the Parliament, by holding a majority of parliamentary
seats, its political power is substantially higher. In parliamentary systems, 13 out of 14 countries in our sample, a (center-)left parliamentary majority sharply increases the chances that a left-wing government, as opposed to a conservative one, is formed after the election – as we will verify empirically. But also in the US, the only presidential system in our sample, holding a parliamentary majority sharply increases the influence of a political side over the policy-making process. We thus look at whether the expected value of investment, conditional on the share of seats won by (center-)left parties, also tends to display a discontinuity at this 50% threshold. Identification of the economic impact of electoral outcomes is thus based on a ‘smoothness’ assumption, meaning that elections won by a close margin should tend to be quite similar in all respects, except for the color of the winning coalition.

Across several different specifications, we find a significant and economically relevant negative effect of left-wing electoral victories on business investment. This effect is large and significant in the ‘interventionist Left’ subsample, but totally absent in the ‘neoliberal Left’ subsample. In the former, year-on-year investment growth tends to be lower by one half of a standard deviation (around 5 percentage points of investment) in the two years following a left-wing electoral victory. If this effect was entirely due to an increase in the probability of formation of a Left government, the treatment effect of a left-wing cabinet on private investment would be quantifiable in around 0.7 standard deviations (little less than 8% of investment). This relevant negative effect on investment is not matched by any significant effect on GDP growth. As a result, left-wing victories tend to cause, on average, a decrease in the share of business investment in GDP.

This effect does not appear to be driven by any confounding political-stability effect. Using the same RD estimation strategy, we show that electoral victories of incumbent political sides do not cause an higher rate of investment with respect to cases in which the color of the political majority changes. In fact, the positive correlation between incumbents’ electoral victories and investment seems to be entirely driven by the influence of macroeconomic factors on electoral outcomes. Importantly, we also show that at the 50% threshold there is no discontinuity in pre-election macroeconomic conditions, consistently with our identifying assumption of ‘smoothness’.

**Structure of the paper** We proceed in the following steps. The relevant theoretical arguments are summarized briefly in Section 2.2. Section 2.3 relates the present work to the existing empirical literature on the determinants of aggregate business investment and on the economic consequences of political factors. Section 2.4 discusses identification issues and introduces the regression discontinuity (RD) design that we employ to identify
the macroeconomic impact of electoral outcomes. The data employed and the selection of the sample of elections are described in Section 2.5, which also presents descriptive evidence on investment around elections. Section 2.6 reports our RD estimates of the effect of electoral outcomes on business investment, GDP growth and the investment share, along with robustness and covariate balance tests. Section 2.7 concludes.

2.2 Arguments on political shocks and business investment

Theoretically, the idea that entrepreneurs would tend to reduce investment when faced with institutional changes that reduce their social and economic power and their control over the workforce has long been suggested (e.g. Bowles and Gintis, 1986, pp. 88-89; Przeworski and Wallerstein, 1988). In this section we review briefly some possible theoretical foundations of this idea.

It is generally acknowledged, and appears rather uncontroversial, that private investment would be discouraged by (the expectation of) policy measures that drastically weaken private property rights. Przeworski argues that

“increased government intervention means precisely that non-market rationality is imposed upon the process of accumulation, that is, that capitalists are forced to make allocations which are suboptimal with regard to profit. Measures of nationalization, distribution of land, and monopolization of credit and foreign exchange by the state threaten the very institution of private profit. Under such circumstances, rational private capitalists will not invest.” (Przeworski, 1985, p. 45).

The point made by Przeworski appears rather uncontroversial: entrepreneurs will not invest if they don’t expect to be able to earn a rate of return on invested capital at least equal to the (risk-adjusted) interest rate. This alone does not necessarily imply, however, that investment is a monotonic function of the share of capital,\(^2\) nor that all kinds of policies that favor labor are always bound to hurt investment.\(^3\) Abstracting from the limit case of a government that is committed to undermine ‘the very institution of private profit’, further arguments are therefore needed to justify a sensitivity of

\(^2\)See Pariboni (2015, pp. 22-28) for a critical discussion of the idea that investment is a positive function of the profit rate or of the profit share.

\(^3\)Some contributions to the recent debate on the costs of income inequality, for instance, suggest that in principle well-designed State intervention could redistribute income in favor of labor without necessarily hurting (or even enhancing) macroeconomic performance. A recent contribution bringing forward this argument is Stiglitz (2016).
investment to political factors. Overall, these arguments can follow three main lines.

First, political shocks may alter some of the relevant data in the profit-maximization problem faced by rational firms. A stylized model that exemplifies this hypothesis is provided by Przeworski and Wallerstein (1988). They analyze the internal consistency of the proposition according to which, given capitalists’ profit-maximizing behavior, any attempt to redistribute income away from the owners of capital would produce a fall in private investment. According to their stylized model, the theory is not necessarily true in a static sense: there can be pro-labour policies that, once in place, do not reduce private investment; nevertheless, even in these cases, investment would be reduced during the period in which these policies are anticipated but not yet implemented. While Przeworski and Wallerstein (ibid.) focus on direct redistribution policies, evaluations of the potential effect of labor laws on business investment can be found in the industrial relations literature. In particular Budd and Wang (1999, 2004) propose a simple strategic bargaining model, which implies that legislative measures favoring organized labor can reduce the profit-maximizing level of investment of a representative firm.4 A further possibility, if capital enjoys sufficient international mobility, is that a reduction in the expected profit rate in a polity, due to political factors, causes a reallocation of productive plants towards other polities. In this way business investment in the polity could be influenced by the profit rate, even in the absence of overall changes in the optimal investment level of the representative firm.

Second, political shocks could affect what Keynes famously called ‘animal spirits’—autonomous and self-sustaining waves of optimism or pessimism.5 Keynes himself pointed to political events as a major influence on the psychological determinants of business confidence:

“individual initiative will only be adequate when reasonable calculation is supple-

4A critical discussion of these theoretical models is beyond the scope of this paper. It is however fair to note that both models rely on potentially controversial assumptions. Przeworski and Wallerstein (1988), by their own admission (ibid., p.27, note 6), confine their analysis to an ‘ultra-neoclassical’ model of the economy, that rules out by assumption an effect of income on investment. The sensitivity of investment to income growth is however considered overwhelming by both the empirical (as noted in Chirinko, 1993) and part of the theoretical literature (for example Romer, 2012, p. 419)). The model proposed by Budd and Wang (1999), instead, appears to rely crucially on the arguably counter-intuitive assumption that each single firm disposes of a fixed quantity of labour, to be combined with a varying (at least ex-ante) quantity of capital. This amounts to assuming decreasing returns to scale, and thus allows the optimal capital stock to be defined univocally by the rate of return on capital, and to bear a monotonic positive relation to the former.

5See e.g. Akerlof and Shiller (2009) for a recent contribution supporting the idea that psychological forces can influence macroeconomic outcomes. Farmer (2008) provides a concise review of how animal spirits can drive macroeconomic fluctuations even in general-equilibrium models with rational expectations, because of the possibility of multiple equilibria.
mented and supported by animal spirits (...). This means, unfortunately, not only that slumps and depressions are exaggerated in degree, but that economic prosperity is excessively dependent on a political and social atmosphere which is congenial to the average business man. If the fear of a Labour government or a New Deal depresses enterprise, this need not be the result either of a reasonable calculation or of a plot with political intent; – it is the mere consequence of upsetting the delicate balance of spontaneous optimism” (Keynes, 1936, Ch.12).

Electoral outcomes may thus influence investment, according to this explanation, through their impact on business confidence.

Third, it is sometimes suggested that capitalists may somehow manage to act collectively, coordinating on reducing investment in order to weaken a government that they see as not acting in their interest, with the aim of undermining its popularity or inducing it to change policy orientation. (This is the hypothesis of a ‘plot with political intent’ that Keynes refers to in the above quote.) It is fair to note that this hypothesis has been debated more often in the popular press than in academic work.6 We are aware of no theoretical discussion aimed at evaluating under what conditions, if any, such an agreement could be organized and enforced.

A further remark is in order, before concluding this concise review of the relevant theoretical arguments. Potential sensitivity of investment to the institutional-political framework is a necessary but not sufficient condition for electoral shocks to be able to influence investment. It is also necessary that different political coalitions propose distinct policy platforms instead of converging, under competitive pressure, to the same position dictated by the preferences of the median voter, as the well-known Downsian ‘policy convergence theorem’ (Downs, 1957) would predict. There is however a vast literature showing that the Downsian prediction of complete convergence relies crucially on strong assumptions, unlikely to hold in actual political systems, and empirical work has generally found a significant degree of policy differentiation (a recent influential contribution is Lee, Moretti, and Butler, 2004).

2.3 Related empirical literature

This paper can be interpreted as intersecting two strands of empirical literature: that on the determinants of aggregate investment7 and that on the impact of political factors

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6Some old and new examples are Ickes (1938), Frank (2011) and Shlaes (2009).
7Major recent surveys, reviewing both theoretical and empirical contributions, are Baddeley (2003), Caballero (1999), Chirinko (1993), and Jorgenson (1971).
on economic variables.\(^8\)

The empirical literature on investment is huge. In a sense, however, its focus has been rather narrow. Most studies have focused on the role of price and quantity variables in influencing the gross investment level of a firm. Mainly, they have been guided by the neoclassical theory of investment. As a consequence, attention was mostly devoted to the quantification of the impact of the cost of capital (which is a combination of the relative price of capital goods, the corporate tax rate and the interest rate) and of Tobin’s q (the ratio between the stock market valuation of a firm and its replacement cost), with mixed results.\(^9\) Influential deviations from this general trend have been provided by papers studying the effect of financial constraints (following a seminal contribution by Fazzari, Hubbard, and Petersen, 1988) or introducing uncertainty (Pindyck and Solimano, 1993), while some recent studies focus on the implications of non-convex adjustment costs (Caballero and Engel, 1999).

Symmetrically, the literature on the economic impact of political changes has so far paid little attention to investment dynamics. A vast wealth of studies has tested the so-called ‘opportunistic political business cycle’ (incumbent governments would foster economic expansion before elections) and ‘partisan business cycle’ (after the election of a leftist government both inflation and employment would be higher) theories\(^10\). A more recent strand of literature, focusing on US financial markets, has shown that the election of a Republican President tends to cause significant increases in stock market valuations (Snowberg, Wolfers, and Zitzewitz, 2007).

Relatively less attention has been devoted to the implications of political shocks for investment. Gordon, Weisskopf, and Bowles (1998) offer a theoretical and empirical explanation of US business investment dynamics based on institutional and political factors. Several studies, mainly at the firm-level, have attempted to estimate the impact of unionization on investment, generally finding a negative association (Denny and Nickell, 1992; Fallick and Hassett, 1999; Odges and Betts, 1997). Budd and Wang (2004) focus instead on labor policies. Estimating a fixed-effects model in a panel of Canadian provinces, they find investment to be negatively related to the presence of laws that reduce the ability of firms to break strikes.

More directly related to this paper are the few studies concerned with the impact of electoral outcomes on investment. Most of them, however, have focused on political

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\(^8\)See for example Alesina and Roubini, 1992; Nordhaus, 1975; Persson and Tabellini, 1990.

\(^9\)See for example Bernanke, 1988; Blanchard, Rhee, and Summers, 1993; Chirinko, Fazzari, and Meyer, 1999; Cummins, Hassett, and Hubbard, 1994; Schaller, 2007

uncertainty, rather than partisanship. In particular Canes-Wrone and Park (2012) and Julio and Yook (2012) show that pre-electoral uncertainty is associated with lower business investment. An exception is represented by Aubin and Goyeau (1986). Concerned with the French case, they found that in the period 1972-1984 the prospect of an electoral victory of the Left (measured through support for the Left in opinion pools multiplied by the proportion of the electoral term that has elapsed) is associated with a significant decrease in business investment in France, in a time-series regression controlling for output growth and the interest rate. Reverse causality is an obvious potential problem afflicting Aubin and Goyeau’s paper: the association that they find between support for the Left and weak investment could be due to the fact that when the economy weakens the electorate moves leftward, especially if the Left tends to be at the opposition, as in the period they study. Another exception is Pinto and Pinto (2008), which shows that, contrary to received wisdom, more foreign direct investment (FDI) tends to flow in countries ruled by left-wing governments. Their suggested interpretation is that left-wing governments tend to substitute domestic capital with foreign capital. However they correctly warn that their results reveal a correlation, not necessarily a true causal effect.

2.4 Identification problems and research design

**Endogeneity** Our aim is to assess whether business investment dynamics are influenced by political shocks using panel data on 14 OECD countries. Such an analysis faces a major identification problem: electoral outcomes are not exogenous to economic factors. There is ample evidence that macroeconomic conditions affect the probability of an incumbent to be re-elected (see for example the literature survey in Lewis-Beck and Stegmaier, 2000). Moreover, the state of the economy could influence relative support for left-wing versus conservative parties.\(^\text{1}\) Pre-election economic conditions (including unobservable expectations on future growth and employment) influence both electoral outcomes and post-election investment dynamics.

Figure 2.2 displays, as an example, investment dynamics around the elections that brought to the formation of the first Thatcher and Reagan governments. Clearly, these elections happened in a context of deteriorating macroeconomic conditions, translating in a falling rate of investment; and it is widely acknowledged that bad economic conditions played a role in allowing Thatcher and Reagan to win office, beating the incumbent

\(^{11}\)For example Pacek and Radcliff (1995) argue that better macroeconomic conditions could increase participation rates, which in turn have been shown to positively affect vote for the Left.
2.4. Identification problems and research design

RD design Our strategy for tackling endogeneity is based on a Regression Discontinuity design (Hahn, Todd, and Van Der Klaauw, 2001; Imbens and Lemieux, 2008; Lee, 2008). Assume that after each election a treatment is administered to the economy, with a potential impact on macroeconomic outcomes. Treatment can be of two possible types, L (left-wing) or C (conservative). We represent it through a dummy variable $D$ that takes value 1 if $L$ treatment is administered and 0 otherwise. Treatment effects are potentially heterogeneous across countries and periods, depending on variation in economic policy within each political side and different economic conditions. However we are interested in the average treatment effect

$$ATE = E[I(1)_{i,e} - I(0)_{i,e}]$$ (2.1)

where $I(1)_{i,e}$ is the investment that would be realized in country $i$ after election $e$ if $L$ won, and $I(0)_{i,e}$ is the investment that would be realized if $C$ won.

Obviously, however, we cannot observe both outcomes for the same unit simultaneously, but only the realized one. Formally, for each election $\{i,e\}$ we observe

---

The well-know 1979 campaign poster of the UK Conservative Party, displaying a long snaking queue at an unemployment office accompanied by the slogan ‘Labour isn’t working’ is considered one of the most successful political advertising campaign of all times (Gibson, 1999), an example of how bad macroeconomic conditions can play against the incumbent government.
\[ I_{i,e} = (1 - D) \cdot I_{i,e}(0) + D \cdot I_{i,e}(1) = \begin{cases}  
I_{i,e}(0) & \text{if } D_{i,e} = 0 \\
I_{i,e}(1) & \text{if } D_{i,e} = 1 
\end{cases} \quad (2.2) \]

In order to estimate our causal effect of interest \([ATE]\) a simple comparison of average outcomes conditional on treatment status would not work. As discussed above, pre-determined macroeconomic factors may influence both the probability of receiving treatment and the after-election investment rate, introducing selection bias.\(^{13}\)

For each election, however, we also observe the scalar \([X_{i,e}]\), the share of parliamentary seats won by center-left parties. The probability that treatment \(L\) is administered to the economy depends (imperfectly) on whether center-left parties win a majority of parliamentary seats, i.e., whether \(X_i\) crosses the 50% threshold. The probability of observing \([D = 1]\), therefore, jumps discontinuously at the threshold:

\[ \lim_{x \downarrow 0.5} \Pr(D_{i} = 1 | X_{i} = x) \neq \lim_{x \uparrow 0.5} \Pr(D_{i} = 1 | X_{i} = x) \quad (2.3) \]

Our crucial identifying assumption is smoothness or, more precisely, continuity of the conditional regression function at the threshold:

\[ E[I(0)|X = x] \text{ and } E[I(1)|X = x] \text{ are continuous in } x \text{ at } x_0 = 0.5 \quad (2.4) \]

Under this ‘smoothness’ assumption, the rule in eq.2.3 implies that the average treatment effect at the threshold can be expressed as the jump in the conditional expectation of the outcome, divided by the jump in the conditional expectations of treatment:

\[ ATE_{rd} = E[I(1)_{i,e} - I(0)_{i,e}| X = x_0 = 0.5] = \frac{\lim_{x \downarrow 0.5} E[I|X = x] - \lim_{x \uparrow 0.5} E[I|X = x]}{\lim_{x \downarrow 0.5} E[D|X = x] - \lim_{x \uparrow 0.5} E[D|X = x]} \quad (2.5) \]

Where \(ATE_{rd}\) is the average causal effect of the treatment at the discontinuity point.\(^{14}\)

\(^{13}\)In other words, economies that received treatment \(L\) may be systematically different with respect to those that received treatment \(C\). This selection bias can be written as \(E[I_{i,e}(0)|D_{i,e} = 1] \neq E[I_{i,e}(0)|D_{i,e} = 0]\). So a simple comparison of mean observed investment \(E[I_{i,e}|D_{i,e} = 1] - E[I_{i,e}|D_{i,e} = 0]\) would yield the sum of two effects: the portion of the difference between treated with \(C\) and treated with \(L\) that is due to treatment (i.e., our effect of interest, \(ATE\)), plus the portion due to pre-determined factors which render economies picking \(L\) systematically different from economies picking \(C\) (i.e., the selection bias).

\(^{14}\)As pointed out by Lee (2008), being \(x\) a continuous variable, \(x = x_0\) is actually a measure-zero event, so it is somehow misleading to define \(ATE_{rd}\) as the average treatment effect for units with \(x = x_0\). More appropriately, \(ATE_{rd}\) can be seen as a weighted average treatment effect for the entire population, with weights equal to the probability of picking a value near to \(x_0\) (ibid., p. 680).
The two conditional expectation functions forming the ratio in the right side of eq.2.5 can be approximated by appropriate regression functions. In particular, eq.2.5 can be calculated empirically as the jump in a regression of \( I_{i,e} \) on \( X_{i,e} \) at \( x_0 = 0.5 \), divided by the jump in a regression of \( D \) on \( X \) at the same threshold value. This is equivalent to using the indicator variable \( [Z = I(X \geq 0.5)] \) as an instrumental variable for \( D \).

A natural interpretation of \( D \) is that it represents an indicator for whether a left-wing government is formed after the election. Indeed, under the assumption that the only relevant effect of a center-left (conservative) parliamentary majority is to greatly increase the probability that a left-wing (conservative) government is formed, we could observe \( D \) by looking at the color of the government that is formed after the election, and thus estimate the ratio in eq.2.5.

However this assumption (this exclusion restriction, according to the instrumental-variables interpretation of eq.2.5) does not appear to be fully satisfied in our sample. Even when left and center-left parties do not manage to form a government, the fact that they have a majority of seats in Parliament can have relevant implications, as the role of Parliaments is obviously not limited to electing Prime Ministers. Indeed our sample includes one presidential system – the US – where control of the House gives relevant political power to a Party, even if it does not imply control of the White House.

For these reasons, we will focus mainly on estimating the numerator of eq.2.5 – the effect of a center-left parliamentary majority on investment – which in the light of eq.2.5 might represent a conservative estimate of the average treatment effect of the Left being in power. We will present also estimates of the first stage (the denominator of eq.2.5), that is, the effect of a center-left majority on the probability that a left-wing government is formed, and of the \( ATE \) of left-wing governments. However we don’t emphasize this latter measure too much, as the exclusion restriction – the assumption that a center-left parliamentary majority affects the economy only by facilitating the formation of a Left-led government – certainly does not hold for all observations.

**Defining political change** A further potential problem is related to the identification of relevant political variation. We are interested here in the effect of left-wing pro-labour parties, as opposed to pro-business conservative ones, being in power. This could influence investment, as discussed in Section 2.2, because of possible consequences on property rights, capital taxation, labor laws and business confidence. It is dubious that we can identify this kind of political variation just by looking at whether a party is traditionally labeled as (center-)left or conservative, mainly because of the ideological shift that most major western left parties have undertaken in recent decades (Mudge,
Chapter 2. Political shocks and business investment

2011; Scanlon, 2001; Schmidtke, 2002). Consider, as an example, the UK Labour Party. From the columns of the New Left Review, in November 1965, Robert Rowthorn argued that “when the Labour Party came to power last year, it was widely believed in the Labour movement that this was the beginning of a long period of socialist construction”. Obviously such a statement could never have been referred to the post-1994 ‘New’ Labour.\footnote{For example Eric Hobsbawm is quoted in Hall (1998, p. 11) as arguing that “New Labour is not a centre-left government in any traditional sense”.

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To address this problem we identify, in our sample of elections, a subset of episodes in which the electoral platform of the major left party was relatively more radical in terms of property rights, market regulation and State intervention in the economy, employing to this end the estimates of policy positions proposed by Lowe et al. (2011). In this way we will attempt to distinguish the left-wing ‘old’ Labour from the centrist New Labour, and in general socialist and social-democratic parties from centrist ‘third way’ left parties.

2.5 Data, selection of electoral events and estimation method

2.5.1 Data and sources

Macroeconomic variables As an indicator of business investment dynamics – our main outcome variable of interest – we employ the percent change in private non-housing investment over the same quarter of the previous year (i.e., the year-on-year quarterly growth rate). Private non-residential investment data for 14 OECD countries for the period 1960-2013 are taken from the OECD Economic Outlook.\footnote{Of the countries for which the OECD EO provides aggregate business investment data, we exclude only South Korea, due to its particular political structure and lack of any major left-wing party, potentially able to win an election, in the period considered. In a previous preliminary draft of this work (still available at \url{https://www.umass.edu/economics/sites/default/files/Girardi.pdf} ) we included South Korea, with no changes in the sign and significance of the main results.}

In the case of the US, comparable data from the Bureau of Economic Analysis (BEA) allow us to expand the series backwards to cover the period 1919-2013. Also data on quarterly real GDP growth is taken from OECD data\footnote{Available at \url{http://stats.oecd.org/}}. The GDP growth series for the US is extended backwards, to match the time extension of the investment series, using the historical data provided by Balke and Gordon (1986).
Election data  We consider the 227 general elections that occurred during our investment sample period. The estimates of policy positions provided by Lowe et al. (2011), available for 215 of these elections, are used to distinguish traditional left parties from ‘third way’ centrist left parties.\footnote{Lowe et al. (2011) build their measures of parties’ positions using Manifesto Project (MP) data (Lehmann et al., 2015). Specifically, they use a ‘logit scale’, which they show to be superior to other existing methods for scaling continuous policy positions from coded political text. The dataset was retrieved from \url{http://hdl.handle.net/1902.1/17073}} Specifically, we select those elections in which the indicator ‘state intervention in the economy’ for the main (center-)left party is above its median value.\footnote{This index aggregates several policy dimensions related to economic policy, as corporate taxes, private property, market regulation and state intervention in general. Actually, this indicator assigns lower values to parties that propose higher State intervention. So we actually select episodes in which the value of this indicator is below its median value according to their database.} The resulting ‘interventionist Left’ sub-sample comprises 107 general elections.\footnote{Of course this is an arbitrary choice and it does not ensure that all left parties in the ‘interventionist Left’ subsample are characterized by interventionist policies, but it should ensure that they are on average to the Left of those in the ‘neoliberal Left’ subsample.}

To calculate the share of seats won by left and center-left parties, we use the Manifesto Project database (Lehmann et al., 2015).\footnote{Specifically the version contained in Lowe et al. (2011), retrieved from the url indicated in note 18.} We include in the calculation the major left party plus, when present, other left and center-left parties. In cases in which there is a stable center-left electoral alliance (e.g. the \textit{Union de la gauche} – Left Union – in France), we take the parliamentary seats won by this coalition. In other cases, we include all centre-left and left parties, also if not bound by an electoral pact. Table A2 indicates which party we have considered, in each country, as the main left party and which parties were included in the calculation of the (center-)left share of parliamentary seats.

The World Bank’s Database of Political Institutions (DPI) is used to classify governments as either Left-led or Conservative-led. The DPI classification is based on the affiliation of the head of government\footnote{While the DPI classifies the US Democratic Party as Center, we classify it as Left, because it occupies the left of the US political spectrum.}. The World Bank DPI covers the period 1975-2012. We extend the series to the 1960-2013 period by collecting information from different sources.\footnote{Specifically, we extract the information necessary to extend the DPI series from Swank (1950-2011), and apply the same criteria employed by the DPI. For years in which neither the DPI nor Swank provide the data, we use Wikipedia.}

In three cases in our sample (Netherlands 1977; Norway 1985; Belgium 2010) elections gave rise to extraordinary long stalemates, leaving the country without an elected government for long periods (208 days in Netherlands in 1977; 240 days in Norway in
Chapter 2. Political shocks and business investment

1985-86; 541 days in Belgium in 2010-2011 – this latter is a World record). The presence of these three cases in the sample may raise concerns, given that they represent extreme cases of political uncertainty that could distort estimates. We try three options: dropping them from the sample; including them and leaving the date of the political shock equal to the date of the election; including them but postponing the date of the political shock to the date in which a government was finally formed. Reassuringly, all our results turn out to be insensitive to this choice. Our preferred option is to exclude these three elections, and we do so in the estimations presented in the remainder of this paper.

Table A1 provides a list of all elections in our sample, together with: the value of the 'state involvement in the economy' index for the main left party; the share of seats won by center-left parties; the election result based on the color of the government that was formed after the election.

2.5.2 Descriptive statistics and evidence of reverse causality

Table 2.1 reports the distribution of elections in our sample by country and by outcome, while Table 2.2 presents descriptive statistics on our variables of interest.

To provide a preliminary overview of the data, Figures 2.3 display event-study graphs, plotting average investment dynamics around elections. We consider separately all possible combinations of two outcome categories (Left/Conservative; Continuation/Change). Not surprisingly, clear pre-election trends are apparent, suggesting that electoral outcomes are endogenous to economic conditions. In particular, left-wing continuations tend to be preceded by above-average and increasing investment growth; conservative changes, to the contrary, tend to be preceded by below-average and decreasing investment. These trends appear consistent with a positive effect of macroeconomic conditions on both government continuations and Left victories.

2.5.3 Estimation method

We estimate the following reduced form relation between election results and macroeconomic outcomes

\[ I_{i,e,q} = \alpha + \gamma Z_{i,e} + f(x_{i,e}, m_{i,e,q}) + \epsilon_{i,e,q} \quad \text{for } 1 \leq q \leq 8 \]  

where \( I_{i,e,q} \) is the realization of the outcome variable \( q \) quarters after election \( e \) in country \( i \); \( x \) is the left share of parliamentary seats; \( Z \) is an indicator equal to 1 if \( x \geq 0.5 \) and 0 otherwise; \( m \) is a vector of additional control variables; \( f() \) is a potentially non-
2.5. Data, selection of electoral events and estimation method

Figure 2.3: Average business investment growth around elections

Notes: Investment growth taken in standard deviations from the country average. Quarters relative to the election on the horizontal axis. Sources indicated in the text.

linear function that we approximate through kernel-weighted local linear regression.\footnote{Specifically, we employ a triangular kernel. Results are however robust to using a rectangular kernel.}

Under the assumption of ‘smoothness’ (eq. 2.4), $\gamma$ is an unbiased estimate of the local average treatment effect of a left parliamentary majority on investment.

We also estimate the first stage relation

$$D_{i,e} = \lambda + \beta Z_{i,e} + g(x_{i,e}, m_{i,e}) + \eta_{i,e} \quad \text{for } 1 \leq q \leq 8$$  \hspace{1cm} (2.7)

where $D_{i,e}$ is a dummy equal to 1 if a left-lead government is formed after election $e$. Two-stage Least Squares (2SLS) estimation of 2.7 and 2.6 would allow us to recover the local ATE of left-wing governments (equal to $\frac{\gamma}{\beta}$). The exclusion restriction that must be
imposed to identify the latter, however, is unlikely to completely hold in our sample, as discussed in Section 2.4 above. So we focus mainly on the reduced form relation in eq.2.6 and present the 2SLS estimation of the ATE of Left governments only as a potentially useful, although possibly upward-biased, indication.

2.6 Effect on business investment

2.6.1 Baseline results

Results on the impact of electoral outcomes on subsequent business investment growth are displayed in Table 2.3. Columns 1 to 4 include the whole sample of elections. Columns 5 to 8 focus on our sub-sample of interest, the elections in which the Left’s proposed economic policy was relatively more radical (the ‘interventionist Left’ subsample). Estimations in columns 9 to 12 are performed on the elections in which the main left party was more centrist (the ‘neoliberal Left’ subsample).

In each subsample, we try four different specifications: employing the optimal bandwidth, defined as in Imbens and Kalyanaraman (2012), without including control variables (columns 1, 5 and 9);\(^{25}\) reducing the bandwidth by one half with respect to the optimal one (columns 2, 6 and 10); using the optimal bandwidth and controlling for decade fixed effects (columns 3, 7 and 11); using the optimal bandwidth and controlling for decade fixed effects and for the average growth rate of business investment in the year preceding the election (columns 4, 8 and 12).\(^{26}\)

Standard errors are clustered by country. The small number of clusters, which may result in underestimated standard errors (Cameron and Miller, 2015, p. 341), is an obvious concern.\(^{27}\) We address it by reporting, for each specification, the p-value for the reduced form effect estimated through the wild cluster bootstrap procedure (Cameron, Gelbach, and Miller, 2008).

In the whole sample of elections, the effect of a center-left parliamentary majority on business investment is negative in all specifications (with a point estimate that varies

\(^{25}\)Note that the inclusion of control variables is not necessary to obtain unbiased estimates of the local effect of interest in a RD design. However it may improve precision. (Lee, 2008, p. 682)

\(^{26}\)Country fixed effects are likely to be very relevant in explaining the level of investment. However country fixed effects in levels are already controlled for by taking growth rates. That is why we don’t include them as additional regressors.

\(^{27}\)Elections from 14 countries are included in the analysis. However, estimation of local linear regressions – thus focusing only on close elections – implies that not all elections (and thus countries) are included in all specifications. Tables 2.3 to 2.6, which report results, indicate the number of elections and countries that fall within the chosen bandwidth in each local regression.

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2.6. Effect on business investment

between $-0.12$ and $-0.50$) but far from statistical significance. In the ‘interventionist Left’ subsample, however, the estimated effect is stronger (point estimates between $-0.44$ and $-0.77$) and statistically significant. In our preferred specification, which controls for decade effects and pre-election investment growth, the presence of a left parliamentary majority causes a decrease by 0.48 standard deviations in business investment growth, with a wild-bootstrap p-value of 0.005. The estimated effect is similar in the specification without controls ($-0.44$), while it is higher when including only decade effects ($-0.71$) and when reducing the bandwidth by one half ($-0.77$). In the latter case, as expected, it is also less precisely estimated. In the ’neoliberal Left’ subsample we find no negative effect of Center-Left electoral victories on investment: point estimates are slightly positive and completely insignificant (with a wild bootstrap p-value that varies between 0.56 to 0.83 across specifications).

The first stage relation is strong and significant in all sub-samples. Point estimates suggest that when the (center-)left share of parliamentary seats crosses the 50% threshold, the probability that a Left-led government is formed jumps by between 47% and 68%. Under the (debatable) assumption that the treatment only works through an higher probability of a left-wing government, we can scale the reduced form effect by the first stage. The implied average treatment effect of left-wing governments is $-0.74$ standard deviations in our preferred specification (column 8) and varies between $-0.66$ and $-1.61$ in the other specifications.

The effect of a center-left parliamentary majority on the probability of formation of a Left-led government in the whole sample is displayed graphically in Figure 2.4 panel (a), while the effect on business investment is displayed separately for the two sub-samples in Figures 2.5. The depicted regression lines are estimated using kernel-weighted local linear regression with the optimal bandwidth. In Figures 2.5 business investment is residualized on decade effects and pre-election investment growth, in analogy with our preferred specification.
Chapter 2. Political shocks and business investment

Table 2.1: Elections in the sample by country and outcome

<table>
<thead>
<tr>
<th>Country</th>
<th>‘Interventionist Left’ subsample</th>
<th>‘Neo-liberal Left’ subsample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$L_{ch}$</td>
<td>$L_{co}$</td>
</tr>
<tr>
<td>Australia</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Belgium</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Canada</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Denmark</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Finland</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>France</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Germany</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Japan</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Netherlands</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>New Zealand</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Norway</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Sweden</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>UK</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>USA</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>12</td>
<td>26</td>
</tr>
</tbody>
</table>

Notes: Election outcomes are classified as follows: $L_{ch}$ = left-wing changes; $L_{co}$ = left-wing continuations; $R_{ch}$ = conservative changes; $R_{co}$ = conservative continuations.

Table 2.2: Descriptive statistics

<table>
<thead>
<tr>
<th></th>
<th>Obs.</th>
<th>Mean</th>
<th>Std.Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment growth (q)</td>
<td>2,984</td>
<td>4.16</td>
<td>10.36</td>
<td>-49.56</td>
<td>74.30</td>
</tr>
<tr>
<td>GDP growth (q)</td>
<td>3,012</td>
<td>2.92</td>
<td>3.41</td>
<td>-19.91</td>
<td>22.94</td>
</tr>
<tr>
<td>Investment share (q)</td>
<td>2,860</td>
<td>10.8</td>
<td>2.75</td>
<td>3.94</td>
<td>20.8</td>
</tr>
<tr>
<td>Left victory</td>
<td>227</td>
<td>0.40</td>
<td>0.49</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Continuation</td>
<td>227</td>
<td>0.66</td>
<td>0.47</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Left Stateconomy</td>
<td>215</td>
<td>-1.76</td>
<td>1.10</td>
<td>-4.76</td>
<td>1.63</td>
</tr>
<tr>
<td>Incumbent seats (%)</td>
<td>227</td>
<td>0.54</td>
<td>0.13</td>
<td>0.13</td>
<td>0.83</td>
</tr>
<tr>
<td>Left seats (%)</td>
<td>227</td>
<td>0.43</td>
<td>0.12</td>
<td>0.13</td>
<td>0.77</td>
</tr>
</tbody>
</table>

Notes: Investment growth is the year-on-year quarterly growth rate of real business fixed investment. GDP growth is the year-on-year quarterly growth rate of real Gross Domestic Product. Stock market growth is the year-on-year monthly growth rate of an index of real domestic share prices. Profit share is net operating surplus (adjusted for imputed compensation of self-employed) as a share of GDP. For each election in the sample, Left victory is an indicator variable equal to 1 if a Left-led government is formed after the election; Continuation is equal to 1 if the incumbent political party is confirmed; Left Stateconomy is the index ‘state involvement in the economy’ for the major left-wing party of the country (extracted from Lowe et al., 2011); Incumbent Seats is the share of parliamentary seats won by the incumbent coalition; Left Seats is the share of parliamentary seats won by the Left (or Center-Left) parties or coalition.
## Table 2.3: Effect of a Left parliamentary majority on private non-housing investment growth (RD Estimates)

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
<th>(9)</th>
<th>(10)</th>
<th>(11)</th>
<th>(12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced form</td>
<td>-0.17</td>
<td>-0.50</td>
<td>-0.19</td>
<td>-0.12</td>
<td>-0.44</td>
<td>-0.77</td>
<td>-0.71</td>
<td>-0.48</td>
<td>0.18</td>
<td>0.19</td>
<td>0.16</td>
<td>0.16</td>
</tr>
<tr>
<td></td>
<td>(0.21)</td>
<td>(0.43)</td>
<td>(0.23)</td>
<td>(0.27)</td>
<td>(0.22)</td>
<td>(0.35)</td>
<td>(0.26)</td>
<td>(0.24)</td>
<td>(0.39)</td>
<td>(0.15)</td>
<td>(0.43)</td>
<td>(0.37)</td>
</tr>
<tr>
<td>First stage</td>
<td>0.55</td>
<td>0.60</td>
<td>0.55</td>
<td>0.55</td>
<td>0.67</td>
<td>0.47</td>
<td>0.67</td>
<td>0.67</td>
<td>0.88</td>
<td>0.62</td>
<td>0.68</td>
<td>0.68</td>
</tr>
<tr>
<td></td>
<td>(0.26)</td>
<td>(0.39)</td>
<td>(0.26)</td>
<td>(0.26)</td>
<td>(0.26)</td>
<td>(0.39)</td>
<td>(0.26)</td>
<td>(0.26)</td>
<td>(0.28)</td>
<td>(0.36)</td>
<td>(0.28)</td>
<td>(0.28)</td>
</tr>
<tr>
<td>2SLS (Effect of Left Gov.)</td>
<td>-0.30</td>
<td>-0.83</td>
<td>-0.38</td>
<td>-0.22</td>
<td>-0.66</td>
<td>-1.61</td>
<td>-1.22</td>
<td>-0.74</td>
<td>0.26</td>
<td>0.30</td>
<td>0.25</td>
<td>0.26</td>
</tr>
<tr>
<td></td>
<td>(0.46)</td>
<td>(0.85)</td>
<td>(0.53)</td>
<td>(0.52)</td>
<td>(0.53)</td>
<td>(1.54)</td>
<td>(0.60)</td>
<td>(0.57)</td>
<td>(0.48)</td>
<td>(0.21)</td>
<td>(0.59)</td>
<td>(0.52)</td>
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<tr>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>✓</td>
</tr>
<tr>
<td>Pre-election investment</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Bandwidth</td>
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<td>0.031</td>
<td>0.062*</td>
<td>0.062*</td>
<td>0.079*</td>
<td>0.039</td>
<td>0.079*</td>
<td>0.079*</td>
<td>0.090*</td>
<td>0.090*</td>
<td>0.090*</td>
<td>0.090*</td>
</tr>
<tr>
<td>Wild bootstrap p-value</td>
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<td>0.43</td>
<td>0.30</td>
<td>0.27</td>
<td>0.04</td>
<td>0.33</td>
<td>0.005</td>
<td>0.005</td>
<td>0.56</td>
<td>0.75</td>
<td>0.62</td>
<td>0.83</td>
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<td>333</td>
<td>372</td>
<td>185</td>
<td>372</td>
<td>364</td>
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<tr>
<td>Elections</td>
<td>79</td>
<td>43</td>
<td>79</td>
<td>79</td>
<td>46</td>
<td>27</td>
<td>46</td>
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<td>50</td>
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<td>50</td>
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<td>Countries</td>
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<td>10</td>
<td>12</td>
<td>9</td>
<td>12</td>
<td>12</td>
</tr>
</tbody>
</table>

Results from kernel-weighted local linear regressions (triangular kernel). Reduced form is the RD estimate of the average effect of a Left Parliamentary majority on (standardized) business investment growth in the two years after the election. First stage is the RD estimate of the effect of a Left Parliamentary majority on the probability of formation of a Left Government. 2SLS is the implied effect of a Left Government on (standardized) business investment growth. Decade fixed effects and pre-election investment growth indicate whether these variables are included as regressors. Standard errors (robust and clustered by country) in parenthesis; Wild cluster bootstrap p-value for the reduced form effect estimated through local linear regression (400 iterations); * denotes the optimal bandwidth.
2.6.2 Robustness

Figures 2.6 display graphically the robustness of the main result— the effect of electoral outcomes on investment in the ‘interventionist Left’ sub-sample — to different specifications. For greater transparency, these graphs show the discontinuity in the raw data (i.e., without residualizing on control variables). In panel (a) kernel-weighted regression lines employ the optimal bandwidth; in (b) the bandwidth is reduced by one half; (c) increases the bandwidth by one third; in panel (d) the expected value of investment growth is modeled through a simple linear trend, instead of the flexible kernel-weighted local regressions used in the baseline; (e) depicts a quadratic trend instead; (f) employs again kernel-weighted regression with optimal bandwidth, but excludes all observations in which the outcome variable deviates by more than 3 standard deviations from the sample mean; column (g) excludes the US from the sample, given its difference in terms of both electoral system (presidential rather than parliamentary) and policy positions with respect to the other countries in the sample; in (h) we instead exclude Swedish elections, that are characterized — as we will see below — by an high number of close left victories in our sample period. Clearly, the negative discontinuity in business investment growth survives all these specification changes.
2.6. Effect on business investment

Figure 2.4: First Stage - % of parliamentary seats and probability of forming a government

\( \text{Fitted} = \text{kernel-weighted local linear regression} \)

\( \text{optimal bandwidth as in Imbens and Kalyanaraman, 2012} \)

Figure 2.5: RD - Left parliamentary seats and business investment after the election

\( \text{Fitted} = \text{kernel-weighted local linear regression} \)

\( \text{optimal bandwidth as in Imbens and Kalyanaraman, 2012} \)

\( \text{Investment growth standardized and residualized on decade dummies and pre-election investment growth.} \)
Figure 2.6: RD - Left parliamentary seats and business investment after the election (‘interventionist Left’ subsample)

Note: Investment growth standardized

70
2.6.3 Covariate balance and density of the forcing variable

**Covariate balance** The identification assumption of smoothness implicit in our RD design (eq.2.4) can to some extent be tested by assessing the presence of discontinuities in pre-determined relevant factors at the threshold. In other words, we can test whether close elections were actually similar in terms of the state of the economy before the election. Symmetrically with what we did in the main regression, we look at macroeconomic variables in the 8 quarters before elections. We are thus estimating eq.2.6, but this time for $-1 \geq q \geq -8$. We estimate the same four specifications employed in the baseline regressions (even though obviously the fourth one, controlling for pre-election investment growth, makes little economic sense).

In Table 2.4, columns 1 to 4, we test for a discontinuity in pre-election income growth – the single most important determinant of investment according to a large empirical literature. Coefficients are small (with point estimates between -0.04 and 0.22) and far from statistical significance. T-statistics based on cluster-robust standard errors vary between 0.12 and 0.88 across specifications; wild bootstrap p-values between 0.26 and 0.97.

In columns 5 to 8 we test for a discontinuity in pre-election investment growth, as empirically estimated investment functions usually display strong autocorrelation. In this case the estimated discontinuity is consistently positive (point estimates between 0.06 and 0.32) but never statistically significant. T-statistics vary between 0.5 and 1.47 across specifications; wild bootstrap p-values lie between 0.15 and 0.58.

Columns 9 to 12 focus on the real interest rate. Point estimates are small and negative (between -0.30 and -0.21 in the different specifications) and also in this case never statistically significant. T-statistics are between -1.37 and -0.61; bootstrap p-values are between 0.33 and 0.64.

To sum up, throughout different specifications we don’t find any statistically significant discontinuity in relevant pre-determined macroeconomic variables. Consistently with our identification assumption, close elections appear to be similar in terms of pre-election GDP growth, investment growth and interest rate.

---

28 In our case autocorrelation is partly induced by having taken year-on-year growth rates.
Table 2.4: Covariate balance tests - Left parliamentary majority and pre-determined covariates (RD estimates, 'interventionist Left' subsample)

<table>
<thead>
<tr>
<th></th>
<th>Pre-election GDP growth</th>
<th>Pre-election investment growth</th>
<th>Pre-election interest rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>Reduced form</td>
<td>0.22</td>
<td>0.04</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td>(0.25)</td>
<td>(0.34)</td>
<td>(0.25)</td>
</tr>
<tr>
<td>First stage</td>
<td>0.63</td>
<td>0.72</td>
<td>0.53</td>
</tr>
<tr>
<td></td>
<td>(0.16)</td>
<td>(0.25)</td>
<td>(0.19)</td>
</tr>
<tr>
<td>2SLS (Effect of Left Gov.)</td>
<td>0.33</td>
<td>0.05</td>
<td>0.17</td>
</tr>
<tr>
<td></td>
<td>(0.34)</td>
<td>(0.41)</td>
<td>(0.41)</td>
</tr>
</tbody>
</table>

Decade FE

|                  | ✓ | ✓ | ✓ | ✓ | ✓ |
| Pre-election investment | ✓ | ✓ | ✓ |

Bandwidth

|                      | 0.12 | 0.18 |

Wild bootstrap p-value

|                      | 0.26 | 0.97 |

Observations

|                      | 445  | 263  | 445  | 445  | 421  | 247  | 421  | 421  | 533  | 318  | 533  | 516  |

Elections

|                      | 62   | 37   | 62   | 62   | 59   | 35   | 59   | 59   | 78   | 50   | 78   | 78   |

Countries

|                      | 13   | 9    | 13   | 13   | 12   | 9    | 12   | 12   | 14   | 11   | 14   | 14   |

Results from kernel-weighted local linear regression (triangular kernel). Reduced form is the RD estimate of the average effect of a Left Parliamentary majority on (standardized) business investment growth in the two years before the election. First stage is the RD estimate of the effect of a Left Government on (standardized) business investment growth in the two years before the election. 2SLS is the implied effect of a Left Government on (standardized) business investment growth. Controls include decade fixed effects and pre-election investment growth. Standard errors (robust and clustered by country) in parenthesis; Wild cluster bootstrap p-value for the reduced form effect estimated through local linear regression (400 iterations); ⋆ denotes the optimal bandwidth.
2.6. Effect on business investment

Density of the forcing variable Another assessment of the validity of the RD design consists in testing for a discontinuity in the distribution of the forcing variable (the share of parliamentary seats won by center-left parties) at the threshold. Such a discontinuity, if significant, may signal the possibility of systematic manipulation of electoral results, in a way that may undermine the RD identifying assumption. We thus perform the formal test proposed by McCrary (2008) for a discontinuity in the density of the forcing variable at the threshold.

The point estimate for the discontinuity is 0.49 with a standard error of 0.34. Although this is not statistically significant at any conventional level (the resulting t-stat is 1.4), the magnitude of the discontinuity, depicted in panel (a) of Figure 2.7, may still raise concerns. As can be inferred from Table A1, however, the high number of very close Left electoral victories (as compared to very close conservative victories) that generates this discontinuity is due to one single country, Sweden. Indeed, when dropping Swedish elections from the sample, as done in panel (b) of Figure 2.7, the estimated discontinuity sharply decreases to 0.18, with a standard error of 0.38 (t-stat 0.47). We found no evidence, in the literature, of electoral manipulation in general elections in Sweden in our sample period. In fact, in the Quality of Elections Database (QED), built by Kelley (2014) on the basis of international election monitoring reports, all Swedish elections are coded as good quality, and no manipulation problems are signaled in any of them.29 Moreover, as shown in panel h of Figure 2.6, our baseline result is robust to excluding Swedish elections from the sample.

2.6.4 Effect on GDP growth and investment share

We have found that left-wing electoral victories tend to cause a significant and economically relevant decrease in business investment growth in the two years after the election. It is natural to ask if there is also some systematic effect on GDP growth.

Columns 1 to 4 of Table 2.5 report estimates of equations 2.6 and 2.7 with quarterly GDP growth in the two years following election as the outcome variable, focusing on the sub-sample of interest. We try the same four alternative specifications employed in estimating the effect on investment. The effect on GDP growth is negative in size, with point estimates between $-0.32$ and $-0.49$ (standard deviations), but not statistically significant. T-statistics vary between -0.86 and -1.77 across specifications, while boot-

29 In particular, we look at the variables a1 (‘overall election quality’) and a2 (‘extent of the problems’) in the QED. Eight Swedish general elections are covered by the QED database (from 1979 to 2002) and they all score 0 (the best possible value, meaning that the election ‘represents the will of the people’ and ‘the assessment does not note any problems’) on both variables.
In columns 5-8 we look instead at the effect on the share of business investment in GDP. In particular, we employ the year-on-year change in the investment share as the outcome variable. Consistently with a statistically insignificant negative effect on GDP, smaller than the effect on investment, we find that Left electoral victories are associated with a sizable but not statistically significant decrease in the investment share, with point estimates between -0.22 and -0.57.

These results are displayed graphically in Figures 2.8. Panel (a) depicts the discontinuity in GDP growth at the threshold. As suggested by the results reported in Table 2.5, it is not very clear whether there is actually a true discontinuity. The discontinuity in the investment share, depicted in panel (b) of Figure 2.8, appears larger and more clear, however as we have seen local regression results suggest that it is not significant.

Overall these results seem to suggest that the effect of left-wing electoral victories on subsequent GDP growth displays high variance. This is consistent with the hypothesis that the negative effect on business investment growth does not necessarily result in a decrease in GDP growth, but often only a reduction in the investment share.
### 2.6. Effect on business investment

Table 2.5: Effect of Left parliamentary majority on GDP growth and investment share  
(RD estimates, ‘interventionist Left’ subsample)

<table>
<thead>
<tr>
<th>Outcome variable</th>
<th>GDP growth</th>
<th>Change in I/GDP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Reduced form</td>
<td>-0.32</td>
<td>-0.49</td>
</tr>
<tr>
<td></td>
<td>(0.36)</td>
<td>(0.57)</td>
</tr>
<tr>
<td>First stage</td>
<td>0.66</td>
<td>0.46</td>
</tr>
<tr>
<td></td>
<td>(0.28)</td>
<td>(0.45)</td>
</tr>
<tr>
<td>2SLS (Effect of Left Gov.)</td>
<td>-0.48</td>
<td>-1.07</td>
</tr>
<tr>
<td></td>
<td>(0.69)</td>
<td>(1.99)</td>
</tr>
<tr>
<td>Decade FE</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Pre-election GDP growth</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Pre-election Δ(I/GDP)</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>0.068*</td>
<td>0.034</td>
</tr>
<tr>
<td>Wild bootstrap p-value</td>
<td>0.53</td>
<td>0.69</td>
</tr>
<tr>
<td>Observations</td>
<td>316</td>
<td>178</td>
</tr>
<tr>
<td>Elections</td>
<td>42</td>
<td>24</td>
</tr>
<tr>
<td>Countries</td>
<td>9</td>
<td>7</td>
</tr>
</tbody>
</table>

Results from kernel-weighted local linear regressions (triangular kernel). Both GDP growth and the year-on-year change in the investment share are standardized. Reduced form is the RD estimate of the average effect of a Left Parliamentary majority on the outcome variables in the two years following election. First stage is the RD estimate of the effect of a Left Parliamentary majority on the probability of formation of a Left Government. 2SLS is the implied effect of a Left Government on the outcome variables. Decade fixed effects, pre-election investment growth and pre-election change in investment share indicate whether these variables are included as additional regressors. Standard errors (robust and clustered by country) in parenthesis; Wild cluster bootstrap p-value for the reduced form effect estimated through local linear regression (400 iterations); * denotes the optimal bandwidth.
Chapter 2. Political shocks and business investment

Figure 2.8: RD - Left parliamentary seats and other outcome variables after the election (‘Interventionist Left’ subsample)

*(a) GDP growth (b) Change in I/Y after the election*

Local averages

Fitted = kernel-weighted local linear regression optimal bandwidth as in Imbens and Kalyanaraman, 2012.

GDP growth and change in investment share are both standardized.

2.6.5 Test for a confounding political-stability effect

Figures 2.3 would suggest that investment is stronger after government continuations. As already mentioned (Section 2.4), this effect is likely to be driven by selection bias: a better state of the economy helps the incumbent political side to win re-election. Still, another mechanism could simultaneously be at work. The re-election of an incumbent government, whatever its color, could encourage private investment, relative to a government change – for example because of lower policy uncertainty and/or established connections. Indeed it is widely held that political stability can be beneficial to investment, even though this argument probably applies more cogently to unstable developing countries than to advanced economies.

We test this hypothesis for two reasons. First, if supported by evidence, it could potentially provide new valuable insights on the influence of political factors on investment. Second, in our sample the share of government continuations is higher among conservative victories than among (centre-)left victories, even if not dramatically: 71% against 62% across all elections; 72% against 68% in the ‘interventionist Left’ sub-sample. If we found a significant and positive government-continuation effect, and if this effect was much stronger than the political effect that we have estimated, the estimated political effect could actually be driven by the stability effect. We thus employ our regression-
2.6. Effect on business investment

discontinuity strategy to test this hypothesis.

Results for the whole sample and for both sub-samples are reported in Table 2.6. When the share of seats won by the incumbent political side reaches the 50% threshold, the probability of a government continuation jumps relevantly. Across different specifications and sub-samples, this first stage effect lies between $+0.55\%$ and $+0.90\%$ and is generally highly significant. This large positive discontinuity is shown graphically in panel (b) of Figure 2.4. There is however no sign of any effect on the rate of growth of business investment after the election. Point estimates for the effect of an incumbent parliamentary majority on business investment growth lie between $-0.08$ and $+0.14$ standard deviations and never reach statistical significance at any conventional level (wild bootstrap p-values vary between 0.47 and 0.99 across specifications). Graphical evidence, displayed separately for the two sub-samples in Figures 2.9, strongly supports this finding of a null effect.

![Figure 2.9](image)

(a) 'Interventionist Left' subsample

(b) 'Neo-liberal Left' subsample

Figure 2.9: RD - Incumbents’ parliamentary seats and business investment after the election

\[ \text{Fitted} = \text{kernel-weighted local linear regression} \]

*(optimal bandwidth as in Imbens and Kalyanaraman, 2012).*

*Investment growth standardized.*
Chapter 2. Political shocks and business investment

Table 2.6: Effect of a confirmation of an incumbent Parliamentary majority on private non-housing investment growth (RD Estimates)

<table>
<thead>
<tr>
<th>Sample</th>
<th>Neoliberal Left</th>
<th>Interventionist Left</th>
<th>All Elections</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
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<td>10</td>
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</tr>
<tr>
<td>10</td>
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<td>12</td>
</tr>
<tr>
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<td>0.09</td>
</tr>
<tr>
<td>0.12</td>
<td>0.13</td>
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<td>✓</td>
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</tr>
<tr>
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<td>✓</td>
</tr>
<tr>
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<td>✓</td>
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<td>(0.21)</td>
<td>(0.20)</td>
<td>(0.25)</td>
<td>(0.26)</td>
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<td>0.086</td>
<td>0.048</td>
<td>0.077</td>
</tr>
<tr>
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<td>⋆</td>
<td>⋆</td>
<td>⋆</td>
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<tr>
<td>0.024</td>
<td>0.034</td>
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<td>0.096</td>
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<tr>
<td>0.048</td>
<td>0.086</td>
<td>0.048</td>
<td>0.077</td>
</tr>
<tr>
<td>⋆</td>
<td>⋆</td>
<td>⋆</td>
<td>⋆</td>
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</tr>
<tr>
<td>⋆</td>
<td>⋆</td>
<td>⋆</td>
<td>⋆</td>
</tr>
</tbody>
</table>

Wild bootstrap p-value: 0.999


Elections: 113, 59, 113, 113, 48, 28, 48, 48, 46, 22, 46, 46

Countries: 12, 11, 12, 12, 10, 8, 10, 10, 12, 8, 12, 12

Sample

Table 2.6: Effect of a confirmation of an incumbent Parliamentary majority on private non-housing investment growth (RD Estimates)

Note:

- Reduced form is the RD estimate of the average effect of the confirmation of an incumbent Parliamentary majority on (standardized) business investment growth in the two years after the election.
- First stage is the RD estimate of the effect of the confirmation of an incumbent Parliamentary majority on the probability that the incumbent Government is confirmed.
- 2SLS is the implied effect of an incumbent Government on (standardized) business investment growth.
- Decade fixed effects and pre-election investment growth indicate whether these variables are included as regressors.
- Standard errors (robust and clustered by country) in parenthesis; Wild cluster bootstrap p-value for the reduced form effect estimated through local linear regression (400 iterations); ⋆ denotes the optimal bandwidth.

- Results from kernel-weighted local linear regressions (triangular kernel).

Wild bootstrap p-value: 0.999
2.7 Concluding remarks

We have used a regression discontinuity (RD) design to assess whether business investment dynamics are influenced by electoral shocks in a sample of 14 OECD countries. Our main outcome variable of interest is the growth rate of business investment in the eight quarters following an election. Our RD approach exploits the fact that when (center-)left parties gain control of the Parliament, by winning more than 50% of parliamentary seats, their political power ‘jumps’ substantially. In parliamentary systems (13 out of 14 countries in our sample) this leads to an higher probability that a Left-led government is formed, as we show empirically, but in all cases it is likely to increase the Left’s influence over policy. We have thus looked at whether the expected value of investment conditional on the (Center-)Left share of parliamentary seats exhibits some jump at the 50% threshold.

In elections in which the Left’s proposed economic policy (as assessed by available estimates of policy positions) is relatively more interventionist, we have found a significant and economically relevant negative effect of left-wing electoral victories on business investment. In our preferred specification, y-o-y business investment growth tends to be lower by one half of a standard deviation (around 5 percentage points of investment) in the two years following a left-wing electoral victory. We find no effect at all, instead, in the subsample in which the Left is more centrist.

The average effect of left-wing electoral victories on GDP growth is also negative, but much lower in absolute value and not statistically significant at any conventional level and in any specification. The effect on the investment share is negative and more relevant, but also imprecisely estimated. This appears consistent with the hypothesis that the negative effect of left-wing victories on business investment growth does not necessarily result in a decrease in GDP growth, but often only in a reduction in the business investment share of GDP.

We have assessed covariate balance by testing for discontinuities in pre-election macroeconomic conditions (specifically GDP growth, investment growth and real interest rate) at the 50% threshold. Reassuringly, we have found none. The McCrary (2008) test points to a statistically insignificant but sizable positive discontinuity in the density of the forcing variable. However we have shown that this (not statistically significant) discontinuity is largely driven by one single country, Sweden, which elections have not been subject to manipulation according to available measures, and thus appears unlikely, in our view, to signal manipulation of the running variable. In addition to this, our baseline result is robust to excluding Swedish elections from the sample.
We have also verified that our main result is not driven by any positive effect of incumbent victories on subsequent investment growth. To the contrary, we find that incumbents’ victories exert no impact on business investment, suggesting that the positive relation between investment and government continuations is entirely driven by endogeneity.

The question arises naturally: what does the Left do to hurt business investment? Left-wing political changes may depress investment by causing a decrease in the profit share or an increase in interest rates (or by the expectation of such effects), or they may create uncertainty and hinder animal spirits, as envisaged by Keynes. This question motivates the next chapter, which will attempt to explore the channels through which left-wing parliamentary majorities depress investment growth.
Appendix

2.A   Elections and parties in our sample

This Appendix provides the list of all elections in our sample, together with: the value of the ‘state involvement in the economy’ index for the main left-wing party; the share of seats won by center-left parties; the election result based on the color of the Government that was formed after the election (Table A1). Moreover, Table A2 indicates which parties we have considered, in each country, as the main left-wing party and which parties were included in the calculation of the center-left share of Parliamentary seats.
<table>
<thead>
<tr>
<th>Country</th>
<th>Date</th>
<th>Sign</th>
<th>Type</th>
<th>State Change</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUS</td>
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<td>right</td>
<td>confirm</td>
<td>0.26</td>
<td>0.49</td>
</tr>
<tr>
<td>AUS</td>
<td>1963q4</td>
<td>right</td>
<td>confirm</td>
<td>-1.67</td>
<td>0.41</td>
</tr>
<tr>
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<td>1966q4</td>
<td>right</td>
<td>confirm</td>
<td>-2.49</td>
<td>0.33</td>
</tr>
<tr>
<td>AUS</td>
<td>1969q4</td>
<td>right</td>
<td>confirm</td>
<td>-2.50</td>
<td>0.47</td>
</tr>
<tr>
<td>AUS</td>
<td>1972q4</td>
<td>left</td>
<td>confirm</td>
<td>-2.33</td>
<td>0.54</td>
</tr>
<tr>
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<td>1974q2</td>
<td>left</td>
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</tr>
<tr>
<td>JPN</td>
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<td>rightwing</td>
<td>confirm</td>
<td>-1.94</td>
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</tr>
<tr>
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<td>change</td>
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</tr>
<tr>
<td>JPN</td>
<td>2012q4</td>
<td>rightwing</td>
<td>change</td>
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</tr>
<tr>
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</tr>
<tr>
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<td>rightwing</td>
<td>change</td>
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<td>0.25</td>
</tr>
<tr>
<td>NLD</td>
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<td>rightwing</td>
<td>confirm</td>
<td>-2.51</td>
<td>0.27</td>
</tr>
<tr>
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<td>change</td>
<td>-2.73</td>
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<tr>
<td>NLD</td>
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<td>confirm</td>
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<td>confirm</td>
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<td>rightwing</td>
<td>confirm</td>
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<td>0.36</td>
</tr>
<tr>
<td>NLD</td>
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<td>rightwing</td>
<td>confirm</td>
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<td>0.37</td>
</tr>
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<td>leftwing</td>
<td>change</td>
<td>-0.63</td>
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</tr>
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<td>leftwing</td>
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<td>-2.10</td>
<td>0.41</td>
</tr>
<tr>
<td>NLD</td>
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<td>rightwing</td>
<td>change</td>
<td>-1.33</td>
<td>0.28</td>
</tr>
<tr>
<td>Country</td>
<td>Date</td>
<td>Sign</td>
<td>Type</td>
<td>Change</td>
<td>Coefficient</td>
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<tr>
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<td>rightwing</td>
<td>change</td>
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</tr>
<tr>
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<td>1978q4</td>
<td>rightwing</td>
<td>confirm</td>
<td>-0.84</td>
<td>0.43</td>
</tr>
<tr>
<td>NZL</td>
<td>1981q4</td>
<td>rightwing</td>
<td>confirm</td>
<td>-0.29</td>
<td>0.47</td>
</tr>
<tr>
<td>NZL</td>
<td>1984q3</td>
<td>leftwing</td>
<td>change</td>
<td>-0.71</td>
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</tr>
<tr>
<td>NZL</td>
<td>1987q3</td>
<td>leftwing</td>
<td>confirm</td>
<td>-2.23</td>
<td>0.59</td>
</tr>
<tr>
<td>NZL</td>
<td>1990q4</td>
<td>rightwing</td>
<td>change</td>
<td>-1.65</td>
<td>0.29</td>
</tr>
<tr>
<td>NZL</td>
<td>1993q4</td>
<td>rightwing</td>
<td>confirm</td>
<td>-1.40</td>
<td>0.47</td>
</tr>
<tr>
<td>NZL</td>
<td>1996q4</td>
<td>rightwing</td>
<td>confirm</td>
<td>-2.54</td>
<td>0.42</td>
</tr>
<tr>
<td>NZL</td>
<td>1999q4</td>
<td>leftwing</td>
<td>change</td>
<td>-1.33</td>
<td>0.49</td>
</tr>
<tr>
<td>NZL</td>
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<td>leftwing</td>
<td>confirm</td>
<td>-1.63</td>
<td>0.45</td>
</tr>
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<td>0.36</td>
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<td>0.51</td>
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<td>1965q3</td>
<td>rightwing</td>
<td>change</td>
<td>-3.05</td>
<td>0.47</td>
</tr>
<tr>
<td>NOR</td>
<td>1969q3</td>
<td>rightwing</td>
<td>confirm</td>
<td>-3.45</td>
<td>0.49</td>
</tr>
<tr>
<td>NOR</td>
<td>1973q3</td>
<td>leftwing</td>
<td>confirm</td>
<td>-3.71</td>
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</tr>
<tr>
<td>NOR</td>
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<td>leftwing</td>
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<td>0.50</td>
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<tr>
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<td>rightwing</td>
<td>change</td>
<td>-2.46</td>
<td>0.45</td>
</tr>
<tr>
<td>NOR</td>
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<td>rightwing</td>
<td>change</td>
<td>-2.84</td>
<td>0.48</td>
</tr>
<tr>
<td>NOR</td>
<td>1993q3</td>
<td>leftwing</td>
<td>confirm</td>
<td>-1.80</td>
<td>0.48</td>
</tr>
<tr>
<td>NOR</td>
<td>1997q3</td>
<td>rightwing</td>
<td>change</td>
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<tr>
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<td>2001q3</td>
<td>rightwing</td>
<td>confirm</td>
<td>-3.43</td>
<td>0.40</td>
</tr>
<tr>
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<td>leftwing</td>
<td>change</td>
<td>-0.51</td>
<td>0.42</td>
</tr>
<tr>
<td>NOR</td>
<td>2009q3</td>
<td>leftwing</td>
<td>confirm</td>
<td>-2.52</td>
<td>0.51</td>
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</table>
List of elections in the sample (continued - 4/4)

<table>
<thead>
<tr>
<th>Ctry</th>
<th>Date</th>
<th>Sign</th>
<th>Type</th>
<th>Statec.</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>1936q4</td>
<td>leftwing</td>
<td>confirm</td>
<td>-0.85</td>
<td>0.77</td>
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<td>USA</td>
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<td>confirm</td>
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<td>0.62</td>
</tr>
<tr>
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<td>leftwing</td>
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</tr>
<tr>
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<td>confirm</td>
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<td>0.60</td>
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<td>1952q4</td>
<td>rightwing</td>
<td>change</td>
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<td>0.49</td>
</tr>
<tr>
<td>USA</td>
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<td>rightwing</td>
<td>confirm</td>
<td>-2.11</td>
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<tr>
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<td>1960q4</td>
<td>leftwing</td>
<td>change</td>
<td>-1.54</td>
<td>0.60</td>
</tr>
<tr>
<td>USA</td>
<td>1964q4</td>
<td>leftwing</td>
<td>confirm</td>
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<td>0.68</td>
</tr>
<tr>
<td>USA</td>
<td>1968q4</td>
<td>rightwing</td>
<td>change</td>
<td>-0.95</td>
<td>0.56</td>
</tr>
<tr>
<td>USA</td>
<td>1972q4</td>
<td>rightwing</td>
<td>confirm</td>
<td>-2.68</td>
<td>0.56</td>
</tr>
<tr>
<td>USA</td>
<td>1976q4</td>
<td>leftwing</td>
<td>change</td>
<td>-2.39</td>
<td>0.67</td>
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<td>USA</td>
<td>1980q4</td>
<td>rightwing</td>
<td>change</td>
<td>-2.53</td>
<td>0.56</td>
</tr>
<tr>
<td>USA</td>
<td>1984q4</td>
<td>rightwing</td>
<td>confirm</td>
<td>-0.70</td>
<td>0.58</td>
</tr>
<tr>
<td>USA</td>
<td>1988q4</td>
<td>rightwing</td>
<td>confirm</td>
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<td>0.60</td>
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<tr>
<td>USA</td>
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<td>change</td>
<td>-0.95</td>
<td>0.59</td>
</tr>
<tr>
<td>USA</td>
<td>1996q4</td>
<td>leftwing</td>
<td>confirm</td>
<td>-1.68</td>
<td>0.48</td>
</tr>
<tr>
<td>USA</td>
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<td>rightwing</td>
<td>change</td>
<td>-1.92</td>
<td>0.49</td>
</tr>
<tr>
<td>USA</td>
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<td>rightwing</td>
<td>confirm</td>
<td>-1.62</td>
<td>0.47</td>
</tr>
<tr>
<td>USA</td>
<td>2008q4</td>
<td>leftwing</td>
<td>change</td>
<td>-0.98</td>
<td>0.59</td>
</tr>
<tr>
<td>USA</td>
<td>2012q4</td>
<td>leftwing</td>
<td>confirm</td>
<td>-0.46</td>
<td></td>
</tr>
</tbody>
</table>

Notes: Countries are denoted by their ISO country codes; Statec. is the index ‘State involvement in the economy’ (Stateconomy) for the major Left party, as calculated by Lowe et al. (2011) on the basis of Manifesto Project data. Lower values are associated with more interventionist platforms. Elections for which stateconomy is below its sample median (-1.625) are included in the ‘Interventionist Left’ subsample, while others are included in the ‘Neoliberal Left’ subsample. SL is the share of seats won by the Left party/coalition in the relevant Chamber of the Parliament.
### Table A2: Parties included in the calculation of Left Stateconomy and of (Center-)Left share of parliamentary seats

<table>
<thead>
<tr>
<th>Country</th>
<th>Main (Center-)Left Party</th>
<th>Parties included in the calculation of Left Stateconomy</th>
<th>(Center-)Left share of seats</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUS</td>
<td>Australian Labor Party (ALP)</td>
<td>Australian Labor Party (ALP)</td>
<td></td>
</tr>
<tr>
<td>BEL</td>
<td>Belgian Socialist Party (BSP)</td>
<td>Belgian Socialist Party (BSP)</td>
<td></td>
</tr>
<tr>
<td>CAN</td>
<td>Liberal Party of Canada (LP)</td>
<td>New Democratic Party (NDP) + Liberal Party of Canada (LP)</td>
<td></td>
</tr>
<tr>
<td>DNK</td>
<td>Danish Social Democrats (SD)</td>
<td>Danish Social Democrats (SD) + Socialdemokraterne</td>
<td></td>
</tr>
<tr>
<td>FIN</td>
<td>Social Democratic Party</td>
<td>Social Democratic Party + Social Democratic Party + Swedish Social Democrats + Sweden Democrats</td>
<td></td>
</tr>
<tr>
<td>GBR</td>
<td>Labour Party</td>
<td>Labour Party</td>
<td></td>
</tr>
<tr>
<td>NOR</td>
<td>Labour Party (DNA)</td>
<td>Labour Party (DNA)</td>
<td></td>
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<tr>
<td>USA</td>
<td>Democratic Party</td>
<td>Democratic Party</td>
<td></td>
</tr>
</tbody>
</table>

Notes: ISO country codes. When a party is not included in all sample elections (because it was not present), the time period in which this party was included is specified in parenthesis.
Chapter 3

Understanding the effect of political shocks on business investment: potential mechanisms and impact dynamics

3.1 Introduction

The empirical analysis presented in the previous chapter, based on a Regression Discontinuity design, has found that left-wing electoral victories tend to affect negatively business investment growth. In particular, in elections in which the Left’s proposed economic policy is relatively more interventionist, year-on-year investment growth tends to be lower by one half of a standard deviation (around 5 percentage points of investment) in the two years following a left-wing electoral victory, according to our findings. Different interpretations and explanations of this result could be advanced (see the discussion in Section 2.2). This finding could indeed be compatible with different theories of investment. In this chapter we provide additional evidence on the effect of left-wing electoral victories on the economy, with the aim of better understanding the negative impact on business investment growth.

First, we explore potential channels of transmission through which political shocks may influence investment (Section 3.3). We thus estimate the effect of left-wing electoral victories on variables that, according to the literature, can influence business investment and, at the same time, can plausibly be affected by economic policy. We have already
estimated, in the previous chapter, the impact on GDP growth, finding it to be negative but much smaller than the effect on investment, and not statistically significant at any conventional level. This suggests that it is not by reducing economic growth that left-wing majorities hinder business investment.\footnote{Of course if an effect on GDP growth was found, this would not have necessarily implied that the effect on GDP caused the effect on investment – the inverse direction of causality would also have been possible.} Here we broaden the analysis by looking at the real interest rate, the share of capital in income, and domestic share prices. To estimate the causal effect of left-wing electoral victories on these variables, we use the same Regression Discontinuity design that we have described and employed in the previous chapter.

We find no significant impact of left-wing electoral victories on the real interest rate and the profit share. However, we do find a strong negative impact on stock market valuations. In the three months around the election, a Left victory tends to decrease the growth rate of domestic share prices by around 1.1 standard deviations on average (which amounts to a decrease in their year-on-year growth rate by as much as around 25\%). Like the negative effect on investment, also this negative impact on share prices appears to be absent in the subsample of elections in which the Left is more centrist.

Second, we attempt to assess the dynamics of the significant impacts, namely the effects on business investment and share prices (Section 3.4). To do so, we estimate a series of ‘moving average regression discontinuities’. We find the impact on stock market valuations to be partly anticipated, notwithstanding our implicit focus on close elections. It is however strongest in the month of the election. The impact on business investment growth appears to be spread on the first six quarters after the election, after which it starts to fade out.

Overall our results suggest that political shocks influence business investment through expectations and business confidence, rather than actual changes in macroeconomic conditions, at least in the short-run.

### 3.2 Data and sources

Given our aim of providing additional elements to interpret and explain the findings of the previous chapter, we focus on the same sample, composed of 14 OECD countries for the 1960-2013 period (1919-2013 for the US).
3.2. Data and sources

**Macroeconomic variables**  The source of (annual) profit share data is the AMECO database.\(^2\) In particular, we calculate the profit share as the ratio of Adjusted Net Operating Surplus to nominal GDP.

The real interest rate is proxied by the annual yield on 10-year government bonds, net of the rate of inflation (as measured by the y-o-y percent change in the Consumer Price Index); both variables come from the OECD and were retrieved from the Federal Reserve Economic Data (FRED).\(^3\) In cases in which 10-year government bond yields data were not available from the OECD, we employ those provided by the IMF Financial Statistics (retrieved from FRED). In country-quarters in which also the latter are unavailable, we interpolate them on the basis of the Central Bank target rates (provided by the OECD and retrieved from FRED) using linear regression.

As an indicator of stock market dynamics, we use monthly stock market indexes provided by the OECD online database.\(^4\) Share price indexes are deflated using the Consumer Price Index (including all items) provided by the OECD.

Series on share prices and real interest rates for the US are extended backwards, to match the time extension of the investment series used in the previous chapter, using the historical data provided by Balke and Gordon (1986). Due to lack of comparable data, it has not been possible to do the same for the profit share.

**Election data**  The elections considered and the sources of political data are the same of the previous chapter, described in detail in Section 2.5 As already explained there, we use state-of-the-art estimates of parties’ policy positions provided by Lowe et al. (2011) to identify a sub-sample of 107 elections in which the major left-wing party is more radical in terms of state intervention in the economy; the remaining 108 elections, in which the Left is more ‘neoliberal’, are used as a sort of control group. As in the previous chapter, we exclude the three cases in our sample in which inconclusive elections led to extraordinarily long stalemates (see Section 2.5 for details).\(^5\)

Descriptive statistics on the macroeconomic and political variables employed in this chapter are reported in Table 3.1.

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\(^2\) Available at [http://ec.europa.eu/economy_finance/ameco/user/serie/SelectSerie.cfm](http://ec.europa.eu/economy_finance/ameco/user/serie/SelectSerie.cfm)

\(^3\) Available at [https://research.stlouisfed.org/fred2/](https://research.stlouisfed.org/fred2/)

\(^4\) Available at [http://stats.oecd.org/](http://stats.oecd.org/)

\(^5\) We have however checked that results are robust to including these elections
Chapter 3. Understanding the effect of political shocks

Table 3.1: Descriptive statistics

<table>
<thead>
<tr>
<th></th>
<th>Obs.</th>
<th>Mean</th>
<th>Std.Dev.</th>
<th>Min</th>
<th>Max</th>
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</thead>
<tbody>
<tr>
<td>Investment growth (q)</td>
<td>2,984</td>
<td>4.16</td>
<td>10.36</td>
<td>-49.56</td>
<td>74.30</td>
</tr>
<tr>
<td>Real interest rate (q)</td>
<td>3,071</td>
<td>2.78</td>
<td>3.11</td>
<td>-16.7</td>
<td>19.7</td>
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<tr>
<td>Stock market growth (m)</td>
<td>8,775</td>
<td>4.59</td>
<td>23.09</td>
<td>-63.5</td>
<td>162.7</td>
</tr>
<tr>
<td>Profit share (y)</td>
<td>698</td>
<td>14.81</td>
<td>4.81</td>
<td>2.08</td>
<td>33.19</td>
</tr>
<tr>
<td>Left victory</td>
<td>227</td>
<td>0.40</td>
<td>0.49</td>
<td>0</td>
<td>1</td>
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<tr>
<td>Continuation</td>
<td>227</td>
<td>0.66</td>
<td>0.47</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Left_Stateconomy</td>
<td>215</td>
<td>-1.76</td>
<td>1.10</td>
<td>-4.76</td>
<td>1.63</td>
</tr>
<tr>
<td>Incumbent seats (%)</td>
<td>227</td>
<td>0.54</td>
<td>0.13</td>
<td>0.13</td>
<td>0.83</td>
</tr>
<tr>
<td>Left seats (%)</td>
<td>227</td>
<td>0.43</td>
<td>0.12</td>
<td>0.13</td>
<td>0.77</td>
</tr>
</tbody>
</table>

Notes: Investment growth is the year-on-year quarterly growth rate of real business fixed investment. Stock market growth is the year-on-year monthly growth rate of an index of real domestic share prices. Profit share is net operating surplus (adjusted for imputed compensation of self-employed) as a share of GDP. For each election in the sample, Left victory is an indicator variable equal to 1 if a Left-led government is formed after the election; Continuation is equal to 1 if the incumbent political party is confirmed; Left_Stateconomy is the index ‘state involvement in the economy’ for the major left-wing party of the country (extracted from Lowe et al., 2011); Incumbent Seats is the share of parliamentary seats won by the incumbent coalition; Left Seats is the share of parliamentary seats won by the Left (or Center-Left) parties or coalition.

3.3 Effect on potential mechanisms: capital share of income, interest rate and share prices

In Section 2.6.4 we have found the effect of left-wing electoral victories on subsequent income growth – the single most important determinant of aggregate business investment according to a vast empirical literature – not to be statistically significant. This suggests that the negative effect of left-wing electoral victories on investment is not due to lower economic growth. Here we focus on other potential mechanisms. Specifically, we provide regression-discontinuity estimates of the effect of electoral outcomes on the share of capital, the real interest rate and stock market dynamics.

These three variables are indicated as potential determinants of aggregate business investment dynamics in the literature. A lower profit share may hamper firms’ investment by decreasing the availability of internal funds, thus exacerbating credit constraints (González, Arestis, and Dejuán, 2013, p. 236; Marglin and Bhaduri, 1990, pp. 152-153). According to neoclassical models, an higher interest rate would depress investment by discouraging mechanization (see Chapter 1 in this thesis, and in particular Section 1.2), although, even accepting the theory, this would appear unlikely to be an important factor in the short-run. But an higher interest rate could also depress investment by reducing
aggregate demand through a decrease in credit growth (Bernanke and Gertler, 1995). Finally, we look at stock market dynamics as an indicator of profitability expectations and business confidence – ‘animal spirits’, in Keynesian terms (Tobin and Brainard, 1977).

3.3.1 Stationarity tests

Our regression-discontinuity strategy implies comparing the realizations of the outcome variables across different elections, held at different points in time. It is thus important to assess whether our outcome variables are stationary. To this end, we perform the Im-Pesaran-Shin unit-root test for dynamic heterogeneous panels (Im, Pesaran, and Shin, 2003). While different unit-root tests for panel settings have been developed, the one proposed by Im, Pesaran, and Shin (ibid.) appears to be most appropriate in our case, for two main reasons: it applies also to unbalanced panels and, most importantly, it doesn’t require the assumption that all individual series follow the same autoregressive structure.\(^6\) We perform the test under two alternative specifications, namely with and without demeaning the variables of interest.\(^7\)

In the case of the real interest rate, the null hypothesis of non-stationarity is overwhelmingly rejected. In both specifications (with and without demeaning) the p-value for the null hypothesis of a unit root in the real interest rate series is lower than \(1 \cdot 10^{-5}\). Also the capital share series appear to be stationary: the presence of a unit root is rejected with p-values of 0.01 (without demeaning) and 0.001 (with demeaning). Unsurprisingly, we cannot reject at any conventional level the null hypothesis of non-stationarity in the case of OECD stock market indexes: the p-value for the null that all series display a unit root is 0.99 without demeaning and 0.29 when demeaning. We thus test whether the growth rate of the variable is stationary. In particular, to cut out seasonal effects, we take the growth rate of the stock market index over the same month of the previous year (i.e., the year-on-year growth rate). As expected, the year-on-year growth rate of stock market valuations is stationary. Specifically, the p-value for the null hypothesis of a unit root is overwhelmingly rejected with a p-value lower than \(1 \cdot 10^{-5}\) in both specifications.

To sum up, we find the interest rate and capital share series to be stationary. The OECD stock market indexes are non-stationary, but their year-on-year growth rate is stationary.

\(^6\)The Im-Pesaran-Shin test is based on the (augmented) Dickey-Fuller unit-root test statistic for individual time-series, averaged across the observation units in the panel (Im, Pesaran, and Shin, 2003).

\(^7\)Levin, Lin, and Chu (2002, p. 7) suggest that demeaning the variables – in the sense of subtracting the cross-sectional average from each series – would enhance the properties of unit-root tests by neutralizing fixed-effect (i.e., cross-sectional dependence).
3.3.2 Descriptive evidence

As done for business investment (Section 2.5.2), we start by providing a preliminary overview of the data. Figures 3.1, 3.2, 3.3 and 3.4 display event study-graphs, plotting the dynamics of our outcomes of interest around elections. We consider four outcome categories: left-wing changes, left-wing continuations, conservative continuations, conservative changes.

Figure 3.1 displays the average dynamics of the real interest rate around these electoral events. The descriptive evidence appears very mixed, with no clear trends pre- and post-elections. There is some sign that the re-election of an incumbent Conservative Government tends to be correlated with a reduction in the real interest rate when the Left party is relatively more interventionist, while Conservative changes would seem to be followed by interest rate increases. There is however no visible trend at all after Left victories.

In Figure 3.2 we look at the average behavior of the profit share around the events of interest. Even in this case there is no visible trend, apart from a correlation between victories of centrist (‘neo-liberal’) Left parties and profit share increases in cases of Government changes. However the trend seems to be pre-existing, suggesting that the correlation may not reflect a true causal effect.

We have found capital share series to be stationary, which suggests that the variable can be taken in levels, as we have done in Figure 3.2. It is important to note, however, that the profit share is likely to be heavily influenced by country specific factors. These country-level fixed-effects may be large enough to dominate and obscure other factors, especially in our relatively small samples. We thus try to look at capital share changes, in order to ‘difference away’ country-specific factors. Specifically, Figure 3.3 looks at the yearly growth rate of the capital share, instead of its level. Indeed this transformation of the data seems to reveal a less plain picture, even though the series still appear to gravitate around zero with no overwhelming trend. There is however some sign that Conservative changes – displayed in panel (a) of Figure 3.3 – would tend to be preceded by a decrease in the profit share and followed by a recovery, while the other cases do not show easily interpretable trends.

Figure 3.4 displays average stock market growth around elections. In this case, one stylized fact emerges very clearly: in the ‘interventionist Left’ subsample, left-wing changes are associated, on average, with a remarkably large decrease in stock market valuations after the election, while there is no such effect in the ‘neoliberal’ Left subsample.
The *prima facie* evidence provided by these event-study graphs is thus suggestive of a negative effect of left-wing electoral victories on stock market valuations, while the real interest rate and the capital share would not appear to display any clear trend. This descriptive evidence, however, is possibly distorted by simultaneity bias, given that economic factors can influence electoral outcomes. Simultaneity bias could produce spurious correlation or confound existing causal relationships. We thus turn to a regression-discontinuity strategy (outlined in Section 2.4) in order to estimate the causal impact of electoral outcomes on these variables.

![Graphs showing average real interest rate around elections](image)

**Figure 3.1: Average real interest rate around elections**

*Notes: Real interest rate in percentage points. Quarters relative to the election on the horizontal axis.*
Chapter 3. Understanding the effect of political shocks

![Graph showing average capital share around elections](image)

**Figure 3.2: Average capital share around elections**

*Notes: Capital share in percentage points. Quarters relative to the election on the horizontal axis.*
3.3. Effect on potential mechanisms

Figure 3.3: Average yearly change in the capital share around elections

Notes: Change in capital share taken in standard deviations from the country average. Quarters relative to the election on the horizontal axis.
Chapter 3. Understanding the effect of political shocks

Figure 3.4: Average growth rate of stock market valuations around elections

Notes: Stock market growth taken in standard deviations from the country average. Months relative to the election on the horizontal axis.
3.3. Effect on potential mechanisms

3.3.3 Estimation method

In analogy with what we have done in Chapter 2 to assess the effect on investment, we estimate the following reduced form relation between election results and our outcome variables of interest

\[ Y_{i,e,q} = \alpha + \gamma Z_{i,e} + f(x_{i,e}, m_{i,e,q}) + \epsilon_{i,e,q} \quad \text{for } 1 \leq q \leq 8 \] (3.1)

where \( Y_{i,e,q} \) is the realization of the outcome variable \( q \) quarters after election \( e \) in country \( i \); \( x \) is the left share of parliamentary seats; \( Z \) is an indicator equal to 1 if \( x \geq 0.5 \) and 0 otherwise; \( m \) is a vector of additional control variables; \( f() \) is a potentially non-linear function that we approximate through kernel-weighted local linear regression.

Under the assumption of ‘smoothness’ (eq.2.4), \( \gamma \) is an unbiased estimate of the local average treatment effect of a left parliamentary majority on investment.

We also estimate the first stage relation

\[ D_{i,e} = \lambda + \beta Z_{i,e} + g(x_{i,e}, m_{i,e}) + \eta_{i,e} \quad \text{for } 1 \leq q \leq 8 \] (3.2)

where \( D_{i,e} \) is a dummy equal to 1 if a Left-led government is formed after election \( e \). Two-stage Least Squares (2SLS) estimation of 3.2 and 3.1 would allow us to recover the local ATE of left-wing governments (equal to \( \frac{\gamma}{\beta} \)). However, as already discussed in Chapter 2, the exclusion restriction that must be imposed to identify the latter is unlikely to completely hold in our sample, as discussed in Section 2.4 above. So we focus mainly on the reduced form relation in eq.3.1 and present the 2SLS estimation of the ATE of Left governments only as a potentially useful, although possibly upward-biased, indication.

3.3.4 Results

Table 3.2 reports results from the estimation of equations 3.1 and 3.2 with these potential mechanisms as the outcome variables. For each outcome variable, we try four different specifications – the same that were used in the previous chapter for estimating the impact on investment.

Real interest rate  Columns 1 to 4 focus on the real interest rate. Point estimates are negative across all specifications, varying between \(-0.38\) and \(-1.25\) standard deviations, but the null of a zero effect cannot be rejected at any conventional level in any

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8Specifically, we employ a triangular kernel. Results are however robust to using a rectangular kernel.
specification (wild bootstrap p-values lie between 0.20 and 0.47 in the four alternative specifications). A negative (or possibly null) effect on the interest rate cannot plausibly be suspected of causing a reduction in business investment, and appears more likely to signal that in some cases monetary authorities may try to compensate lower investment by reducing the reference rate.

Figure 3.5 displays graphically the discontinuity in the post-election real interest rate at the threshold. In panel (a), without control variables, the discontinuity is steep but appears to be largely driven by few outliers near the threshold, while the overall distribution of the variable does not seem to shift. Increasing precision by controlling for decade fixed effects and for the pre-election level of the outcome partly neutralizes these outliers, resulting in a very small (but still negative) discontinuity, as shown in panel (b) of Figure 3.5.

Capital share of income  Columns 5 to 8 of Table 3.2 present RD estimates of the effect of Left electoral victories on the change in the capital share in the two years following the election. The reduced form effect of a left-wing parliamentary majority is negative but far from statistical significance across the four specifications. Moreover it is near zero in our preferred specification, which includes decade effects and the pre-election value of the outcome as additional regressors.

Figure 3.5: RD - Left parliamentary seats and real interest rate after the election

('Interventionist Left’ subsample)

\(Fitted = kernel\text{-}weighted\ local\ linear\ regression\)

\(optimal\ bandwidth\ as\ in\ Imbens\ and\ Kalyanaraman,\ 2012\)

\(Real\ interest\ rate\ standardized.\)
3.3. Effect on potential mechanisms

Figure 3.6 displays graphically the reduced form relation between left seats and the share of capital. The negative discontinuity appears small and possibly driven by outliers in the raw data (panel a) and reduces to virtually zero when improving precision by residualizing on decade effects and the pre-election value of the outcome (panel b).

![Graphical display of reduced form relation between left seats and the share of capital.](image)

- **Panel a** (Raw data): Shows the raw data without residualization.
- **Panel b** (Residualized on decade effects and pre-election value): Displays the residualized data highlighting the reduction of discontinuity.

**Figure 3.6:** RD - Left parliamentary seats and change in the profit share after the election ('Interventionist Left’ subsample)

*Fitted = kernel-weighted local linear regression*

*optimal bandwidth as in Imbens and Kalyanaraman, 2012*

*Yearly change profit share are standardized.*

**Share prices** When measuring the effect on stock market growth in the two years following election, the same time horizon adopted for all other variables, we find a sizable negative and marginally significant effect. However, share prices are likely to react faster than macroeconomic variables to political shocks – with efficient markets the effect should in theory be discounted immediately after the news is known, although this may happen less smoothly for a variety of reasons (see for example Shleifer, 2000 or Barberis and Thaler, 2003). It is also much more likely that part of the effect be anticipated, notwithstanding our focus on close elections. For these reasons, we try to estimate the effect in the 3 months around election. In this time horizon we find a stronger and more significant average effect. We report here – in columns 9 to 12 of Table 3.2 – this latter result.

The reduced form effect of a left-wing parliamentary majority on stock market growth is rather large and negative across all four specifications. Point estimates vary between...
−0.59 and −1.96 (standard deviations). This negative effect is highly significant when employing the optimal bandwidth, both with and without controlling for decade fixed effects, with a wild bootstrap p-value of 0.005 in both cases (columns 9 and 11). It becomes less precisely estimated (as expected) when reducing the optimal bandwidth by one half, as done in columns 10 and 12. Note that in this latter cases the bandwidth is as small as 2.8%, moreover data on share price indexes don’t cover the whole subsample, therefore the number of observations available for estimating the discontinuity becomes very small in these two specifications with an half-of-optimal bandwidth.

The reduced form relation between Left parliamentary seats and stock market growth is displayed graphically in Figures 3.7. Panel (a) looks at the raw data, while panel (b) controls for decade effects. In both cases the negative discontinuity appears rather large, consistently with the estimates presented.

If we are willing to scale this reduced form effect on share prices by the first-stage effect on the probability of formation of a Left government, the implied average treatment effect of Left governments on stock market growth remains very close to the reduced form effect. This happens because in the subset of elections for which we have data on domestic share price indexes, the relation between center-left parliamentary majority and Left-led governments is around one.

Having found a negative effect of left-wing victories on share prices in the ‘interventionist Left’ subsample, it becomes interesting to assess whether there is any such effect in the sub-sample of elections in which the Left’s proposed economic policy is more centrist (the ‘neoliberal Left’ subsample). Note that we have found a negative effect on business investment only in the ‘interventionist Left’ subsample. Therefore under the hypothesis that a lower growth in share prices contributes to lower investment, we should find the effect on stock market growth to be weaker (or null) in the ‘neoliberal Left’ subsample. Results are reported in Table 3.3 and clearly point to a null effect: point estimates change sign depending on the bandwidth employed and lie in the −0.07/+0.54 range; wild bootstrap p-values vary between 0.76 and 0.99 across specifications.

9In this case, of course, it would made no sense to control for pre-election dynamics, as we are trying to capture also part of the anticipated effect, so we have dropped the specification that controls for the pre-election value of the outcome, and substitute it with one that employs the half-of-optimal bandwidth and includes control variables.

10When taking one half of the optimal bandwidth, estimates of the increase in the probability of a Left government actually rise substantially above one. This paradoxical result is due to employing a linear probability model. As a consequence, the scaled (2SLS) estimate of the effect of Left governments is lower than the first stage effect of a left majority. This is of course unreasonable, given that the true first stage effect cannot possibly exceed one. We don’t comment on this lower 2SLS estimates in the main text, as they are merely the result of the drawbacks of a linear probability model.
3.3. Effect on potential mechanisms

Figure 3.7: RD - Left parliamentary seats and stock market growth around election
('Interventionist Left' subsample)

Fitted = kernel-weighted local linear regression
optimal bandwidth as in Imbens and Kalyanaraman, 2012
Standardized year-on-year change in domestic share price index.
Chapter 3. Understanding the effect of political shocks

Table 3.2: Effect of Left parliamentary majority on real interest rate, profit share and share prices (RD estimates, 'interventionist Left' subsample)

<table>
<thead>
<tr>
<th>Outcome variable</th>
<th>Real interest rate</th>
<th>Change in profit share</th>
<th>Stock market growth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reduced form</td>
<td>First stage</td>
<td>2SLS (Effect of Left Gov.)</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td></td>
<td>Reduced form</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td></td>
<td>First stage</td>
<td>(6)</td>
<td>(7)</td>
</tr>
<tr>
<td></td>
<td>2SLS (Effect of Left Gov.)</td>
<td>(8)</td>
<td>(9)</td>
</tr>
<tr>
<td></td>
<td>Decade FE</td>
<td>(10)</td>
<td>(11)</td>
</tr>
<tr>
<td></td>
<td>Pre-election interest rate</td>
<td>(12)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wild bootstrap p-value</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Observation period</td>
<td>Countries</td>
<td>Elections</td>
</tr>
<tr>
<td></td>
<td>3 months around election</td>
<td>9</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>2 after-election years</td>
<td>7</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>5 after-election quarters</td>
<td>9</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>Stock market growth</td>
<td>0.028</td>
<td>0.068</td>
</tr>
<tr>
<td></td>
<td>D1</td>
<td>0.028</td>
<td>0.068</td>
</tr>
<tr>
<td></td>
<td>D2</td>
<td>0.028</td>
<td>0.068</td>
</tr>
<tr>
<td></td>
<td>D3</td>
<td>0.028</td>
<td>0.068</td>
</tr>
<tr>
<td></td>
<td>D4</td>
<td>0.028</td>
<td>0.068</td>
</tr>
<tr>
<td></td>
<td>D5</td>
<td>0.028</td>
<td>0.068</td>
</tr>
<tr>
<td></td>
<td>D6</td>
<td>0.028</td>
<td>0.068</td>
</tr>
<tr>
<td></td>
<td>D7</td>
<td>0.028</td>
<td>0.068</td>
</tr>
<tr>
<td></td>
<td>D8</td>
<td>0.028</td>
<td>0.068</td>
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<tr>
<td></td>
<td>D9</td>
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<td>0.068</td>
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<tr>
<td></td>
<td>D10</td>
<td>0.028</td>
<td>0.068</td>
</tr>
<tr>
<td></td>
<td>D11</td>
<td>0.028</td>
<td>0.068</td>
</tr>
<tr>
<td></td>
<td>D12</td>
<td>0.028</td>
<td>0.068</td>
</tr>
</tbody>
</table>

Results from bandwidth-weighted local linear regressions (triangular kernel). All variables standardized. Reduced form is the RD estimate of the average effect of a Left Parliamentary majority on (standardized) the outcome variable. First stage is the RD estimate of the effect of a Left Parliamentary majority on the probability of formation of a Left Government. 2SLS is the implied effect of a Left Government on the outcome variable. Decade fixed effects, pre-election interest rate and pre-election change in profit share indicate whether these variables are included as additional regressors. Standard errors (robust and clustered by country) in parenthesis; Wild cluster bootstrap p-value for the reduced form effect estimated through local linear regression (triangular kernel). Decade fixed effects, pre-election interest rate and pre-election change in profit share were included as additional regressors. Reduced form, first stage and 2SLS estimates are identical but for the reduced form the reduced form estimate is denoted by the optimal bandwidth.
3.3. Effect on potential mechanisms

Table 3.3: Effect of Left parliamentary majority on stock market dynamics in the ‘neoliberal Left’ subsample (RD Estimates)

<table>
<thead>
<tr>
<th>Outcome variable</th>
<th>Stock market growth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
</tr>
<tr>
<td>Reduced form</td>
<td>-0.07</td>
</tr>
<tr>
<td></td>
<td>(0.41)</td>
</tr>
<tr>
<td>First stage</td>
<td>0.81</td>
</tr>
<tr>
<td></td>
<td>(0.23)</td>
</tr>
<tr>
<td>2SLS (Effect of Left Gov.)</td>
<td>-0.09</td>
</tr>
<tr>
<td></td>
<td>(0.50)</td>
</tr>
</tbody>
</table>

Decade FE ✓ ✓

<table>
<thead>
<tr>
<th>Bandwidth</th>
<th>0.103*</th>
<th>0.052</th>
<th>0.103*</th>
<th>0.052</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wild bootstrap p-value</td>
<td>0.84</td>
<td>0.76</td>
<td>0.91</td>
<td>0.99</td>
</tr>
<tr>
<td>Observations</td>
<td>168</td>
<td>84</td>
<td>168</td>
<td>84</td>
</tr>
<tr>
<td>Elections</td>
<td>56</td>
<td>28</td>
<td>56</td>
<td>28</td>
</tr>
<tr>
<td>Countries</td>
<td>12</td>
<td>8</td>
<td>12</td>
<td>8</td>
</tr>
</tbody>
</table>

Results from kernel-weighted local linear regressions (triangular kernel). Stock market growth is the standardized y-o-y growth rate of the OECD domestic share prices’ index. Reduced form is the RD estimate of the average effect of a Left Parliamentary majority on stock market growth in the three months surrounding the election. First stage is the RD estimate of the effect of a Left Parliamentary majority on the probability of formation of a Left Government. 2SLS is the implied effect of a Left Government on stock market growth. Decade fixed effects indicate whether these are included as additional regressors. Standard errors (robust and clustered by country) in parenthesis; Wild cluster bootstrap p-value for the reduced form effect estimated through local linear regression (400 iterations); * denotes the optimal bandwidth.
Chapter 3. Understanding the effect of political shocks

3.4 Dynamics of the estimated effects

All the regression-discontinuity estimates presented up to this point are somehow static, in the sense that they focus on the average effect on the outcomes of interest in the two years following the election. We now attempt to assess the dynamics of the significant impacts, namely the effects on business investment and share prices. To do so, we estimate a series of ‘moving average regression discontinuities’. Setting the election period at \( t = 0 \) and using the same notation as in eq.3.1, for each time period \( t \) around elections we estimate the following equation

\[
I_{i,e,q} = \alpha_t + \gamma_t Z_{i,e} + f_t(x_{i,e}, m_{i,e,q}) + \epsilon_{i,e,q} \quad \text{for} \quad t - 7 \geq q \geq t \tag{3.3}
\]

We then plot \( \gamma_t \) and its lower and upper bounds (based on cluster-robust standard errors) against \( t \), to assess the dynamics of the impact of Left electoral victories on the outcome \( I \).

Figure 3.8 displays results. Panel (a) reports the dynamic impact on business investment growth (taken in standard deviations from the sample mean). The impact seems to be concentrated in the first six quarters after the election, after which it starts to fade out.

Panel (b) reports the dynamics of the impact on domestic share prices (namely on the standardized growth rate of a domestic share price index). In this case the impact is concentrated in the months just around the election (note that in this case \( t \) represents months, not quarters, around elections), and starts to fade out immediately after. Notwithstanding the implicit focus on close elections that the regression-discontinuity design imposes, there is clear evidence of anticipation. Stock market growth begins to be significantly lower, with respect to what happens around conservative victories, already 7/8 months before the election. The effect seems to become stronger as the election approaches (and probably more information about the likely result comes out) and to start to fade out after the election. There is some sign of a partial rebound of stock market valuations between two and three years after the election.

A possible concern with the ‘moving average’ estimates in Figure 3.8 is that they may be affected by some form of attrition bias. In particular, the probability of an early election may be a negative function of macroeconomic conditions. This may in principle lead to an overestimation of the recovery (or return to normal) of share prices and investment growth after the effect has peaked. The potential relevance of this possible source of attrition can be roughly evaluated by noting that almost 31% of the elections in the ‘interventionist Left’ subsample have no data for quarter +12 (or month +48) relative
3.5 Concluding remarks

In this Chapter, we have tried to provide some further evidence on the relation between electoral outcomes and macroeconomic variables, with the aim of understanding why left-wing electoral victories tend to cause decreases in business investment growth. Specifically, we have used the Regression Discontinuity design outlined in Chapter 2, to estimate the causal impact of electoral outcomes on some variables that, according to the literature, may influence investment dynamics – namely the real interest rate, the capital share of income and stock market valuations.

In addition to this, we have attempted to assess the dynamic pattern of the effect of left-wing victories on business investment and on stock market dynamics, by means of a ‘moving-average’ regression-discontinuity.

Our results can be summarized as follows. The negative effect of left-wing electoral

Figure 3.8: Moving average RD - Dynamic of the effect of a Left parliamentary majority on business investment growth and stock market dynamics (‘Interventionist Left’ subsample)

Notes: Each point \( t \) represents the regression-discontinuity estimate of the average effect of a left parliamentary majority on the outcome variable in the 8 periods up to period \( t \) (details in the text). Both stock market growth and business investment growth are standardized and residualized on decade fixed effects and (in the case of investment) pre-election average investment.

to election, because a new election has occurred before. However a much lower number of elections-series, 18.3% of the total, is discontinued because of an early election before quarter +10 (or month +40).

3.5 Concluding remarks

In this Chapter, we have tried to provide some further evidence on the relation between electoral outcomes and macroeconomic variables, with the aim of understanding why left-wing electoral victories tend to cause decreases in business investment growth. Specifically, we have used the Regression Discontinuity design outlined in Chapter 2, to estimate the causal impact of electoral outcomes on some variables that, according to the literature, may influence investment dynamics – namely the real interest rate, the capital share of income and stock market valuations.

In addition to this, we have attempted to assess the dynamic pattern of the effect of left-wing victories on business investment and on stock market dynamics, by means of a ‘moving-average’ regression-discontinuity.

Our results can be summarized as follows. The negative effect of left-wing electoral
victories on business investment does not appear to be caused by higher interest rates nor a lower capital share in income. In fact, we have found no effect on these variables. The negative impact on business investment is however preceded by a large negative effect on share price indexes. The effect on stock market valuations is partly anticipated, but mostly felt in the three months around an election, when a Left victory tends to decrease the growth rate of domestic share prices by around 1.1 standard deviations on average (which amounts to a decrease in their year-on-year growth rate by as much as around 25%). The impact on business investment growth appears to be spread on the first six quarters after the election, after which it starts to fade out.

We can interpret these findings as suggesting that in our sample left-wing electoral victories have influenced business investment through expectations and business confidence, rather than actual changes in macroeconomic conditions.
Chapter 4

Autonomous demand, economic growth and business investment

Co-authored with Riccardo Pariboni (Department of Economics, Roma Tre University)

4.1 Introduction

Following the Great Recession, which exposed blatantly the flaws of Neoclassical macroeconomics, there has been a surge of interest in alternative macroeconomic theories, mainly of Keynesian inspiration (Figure 4.1).

Among the approaches that have attracted most attention from heterodox scholars, there is the so-called ‘Sraffian Supermultiplier’, a theory which highlights the role of the autonomous components of demand (exports, public spending and credit-financed consumption) as a main driver of investment and output growth.

Since the seminal contribution of Serrano (1995), an intense theoretical debate has taken place (Allain, 2015; Cesaratto and Mongiovi, 2015; Dejuán, 2005; Freitas and Serrano, 2015; Lavoie, 2016; Palumbo and Trezzini, 2003; Park, 2000; Smith, 2012; Trezzini, 1995, 1998). The model has also been utilized as an interpretative tool to explain historical tendencies in output and demand for single countries (Amico, Fiorito, and Hang, 2011; Freitas and Dweck, 2013; Médici, 2010). At the same time, only few attempts have been undertaken to test empirically its main predictions using single-country time-series (in particular Médici, 2011 studies the case of Argentina). With the present work, we intend to perform the first systematic, multi-country empirical test of the implications of the supermultiplier model.

We first introduce and discuss the theoretical model (Section 4.2). Section 4.3 illus-
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Figure 4.1: Searches on Google for ‘Multiplier effect’ and ‘Rational Expectations’
(Monthly indices; 100=peak)
Source: Authors’ own elaboration on Google Trends data

trates the construction of the time-series of the autonomous components of aggregate
demand and of the supermultiplier, for a sample of countries which includes the US,
France, Germany, Italy and Spain. Section 4.4 describes the recent dynamics of output,
autonomous demand and of the supermultiplier in these countries. It also carries out
a simple exercise of alternative growth accounting, calculating the contribution of each
component of autonomous demand and of the supermultiplier to the growth rate of the
economy. We then test empirically three main implications of supermultiplier theory:

(a) for any given value of the supermultiplier, the trend growth rate of output converges,
in the long-run, to the trend growth rate of the autonomous components of aggregate
demand (Section 4.5);

(b) positive changes in autonomous demand cause positive changes in output (Section
4.6);

(c) a higher growth rate of autonomous demand causes a higher investment share in
output (Section 4.7).

In order to test these hypotheses, we will employ cointegration analysis, Granger-causality
tests and instrumental-variables panel regressions.

4.2 Demand-led growth and the supermultiplier model

According to the Sraffian supermultiplier model, originally presented in Serrano (1995),
output growth is shaped by the evolution of the autonomous components of demand:
4.2. Demand-led growth and the supermultiplier model

exports, public expenditure and credit-financed consumption. As a demand-led growth model, the Sraffian supermultiplier displays the following properties:

i the extension to the long-run of the Keynesian Hypothesis, meaning that “in the long period, in which productive capacity changes [...] it is an independently determined level of investment that generates the corresponding amount of savings” (Garegnani, 1992, p. 47);

ii an investment function based on the accelerator mechanism, without at the same time engendering Harrodian instability;

iii the absence of any necessary relation between the rate of accumulation and normal income distribution;

iv an equilibrium level for the degree of capacity utilization equal to the normal, cost-minimizing one;

4.2.1 The ‘Sraffian supermultiplier’ model

To provide a simple baseline formalization, we can start from the following system of equations

\[ Y_t = C_t + I_t + G_t + (X_t - M_t) \]  
\[ C_t = c(1 - \tau)Y_t + C_0t \]  
\[ M_t = mY_t \]  
\[ I_t = h_tY_t = v(1 + g_t^e)Y_t \]

\( Y_t \), the current level of output, is equal to aggregate demand (eq. 4.1). The latter is the sum of consumption \( (C_t) \), investment \( (I_t) \), public expenditure \( (G_t) \) and exports \( (X_t) \), minus imports \( (M_t) \).

Total consumption (equation 4.2) is given by the sum of induced and autonomous consumption. The former is financed out of current income and is thus related to its level; the latter (indicated as \( C_0t \)) is the fraction of aggregate consumption that is financed by credit creation. Imports (equation 4.3) depend positively on the national income level. For simplicity we assume linear consumption and import functions, with \( c \) representing the marginal propensity to consume, \( \tau \) the tax rate and \( m \) the propensity

\[ \text{This formalization of the Supermultiplier model is common in the literature. See for example Cesaratto, Serrano, and Stirati (2003) and Serrano (1995)} \]
to import.

For the sake of simplicity, we assume that all capital is circulating and neglect technical change (as done in Serrano, 1995). The behavior of aggregate business investment is thus described by equation 4.4, where \(v\) is the cost-minimizing capital-output ratio and \(g^e_t\) is the expected growth rate of demand. Investment is thus fully induced by demand growth, according to the accelerator principle. Freitas and Serrano (2015, p. 5) call \(h_t = [v(1 + g^e_t)]\) the marginal propensity to invest, because it indicates the increase in \(I_t\) that a unitary increase in \(Y_t\) would cause.

Autonomous demand \((Z)\) is defined as the sum of autonomous households’ consumption, public expenditure and exports:

\[
Z_t = C_0t + G_t + X_t \tag{4.5}
\]

Autonomous demand thus includes “all those expenditures that are neither financed by the contractual (wage and salary) income generated by production decisions, nor are capable of [directly] affecting the productive capacity of the capitalist sector of the economy” (Serrano, 1995, p. 71).

We label the tax-adjusted marginal propensity to save as \(s = 1 - c(1 - \tau)\) and solve the system given by equations 4.1 - 4.5 for the demand-determined level of output, which can be expressed as the product of autonomous demand and the so-called Supermultiplier:

\[
Y_t = \frac{Z_t}{s + m - h_t} = \frac{Z_t}{s + m - v(1 + g^e_t)} \tag{4.6}
\]

Equation 4.6 implies that the rate of growth of the economy is given by

\[
g^Y = g^Z_t + \frac{\dot{h}}{s + m - h} = g^Z_t + \frac{\dot{v}g^e}{s + m - v(1 + g^e_t)} \tag{4.7}
\]

Of course, equation 4.7 is defined under the assumption that the parameters \(c, \tau; 2\) See Cesaratto, Serrano, and Stirati (2003), Freitas and Serrano (2015) and Lavoie (2016) for specifications of the model with fixed capital. The hypotheses that we will derive from the theoretical model and submit to empirical scrutiny are not affected by the specific formulation of the investment function, so we opt for the simplest one.

3 This represents a significant difference with respect to other heterodox growth models, as for example the Marglin-Bhaduri contribution on growth and distribution (Bhaduri and Marglin, 1990; Marglin and Bhaduri, 1990), where investment is assumed to depend also on the profit share. The assumption that investment is fully induced is well-grounded in the empirical literature on the determinants of investment, which has consistently found a strong accelerator effect, while the effect of price variables has been found to be generally weak or non-existent – see for example Blanchard (1986), Chirinko (1993), Ford and Poret (1990), Kothari, Lewellen, and Warner (2014), and Sharpe and Suarez (2014).

4 In order to have meaningful results, we assume \([c(1 - \tau) - m + v(1 + g^e_t)] < 1\). See Serrano (1995, pp. 80-83) for a discussion of the economic interpretation of this condition.
and \( m \) are fixed. Most importantly, the rate of growth of the autonomous components of aggregate demand \((g^Z)\) is taken as exogenous.

Given the investment function (equation 4.4), the rate of capital accumulation can be written as

\[
g^K_t K_t = h_t \frac{u_t}{v} - 1 = (1 + g^e_t)u_t - 1 \quad (4.8)
\]

where \( u_t \) is the rate of utilization, defined as \( u_t = Y_t / Y^n_t \), where \( Y^n \) is the normal level of output implied by the existing capital stock, that is to say the level of output that would be obtained by utilizing normally (i.e., in the cost-minimizing way) the productive capacity (so we have \( Y^n_t = K_t^v \)).

Given the fixed technical coefficient \( v \), changes in the actual degree of capacity utilization are governed by the following differential equation:

\[
\dot{u} = u_t(g^Y_t - g^K_t) \quad (4.9)
\]

Assume that firms’ expectations on demand growth \((g^e)\) are governed by a gradual adaptive process. In particular, assume that the following stylized process of expectations’ revision is at work:

\[
\dot{g}^e = \gamma(g^Y_t - g^e_t) \quad \text{with} \quad 0 < \gamma < 1 \quad (4.10)
\]

where \( \gamma \) is an adjustment coefficient.

Solving the system of differential equations 4.7-4.10, we obtain the following equilibrium relations:

\[
u^* = 1; \quad g^Y^* = g^K^* = g^Z; \quad h^* = v(1 + g^Z); \quad Y^* = \frac{Z}{s + m - v(1 + g^Z)} \quad (4.11)
\]

Where * indicates the equilibrium value of a variable. The economic intuition is that, if the rate of growth of autonomous demand is sufficiently persistent and the behavioral parameters are sufficiently stable, the economic system converges toward a ‘fully-adjusted’ equilibrium position, in which output increases at the (exogenous) rate of growth of autonomous demand, and productive capacity grows in line with demand.

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5In general normal output will be lower than potential, full-capacity output \((Y^p_t)\). See Kurz (1986), Shaikh (2009), and Steindl (1952) for accurate definitions of normal capacity utilization and for the provision of arguments in favor of normal output being less than full-capacity output.

6The definition of the technical coefficient \( v \) implies \( g^Y_t = g^K_t \).

7For an explicit analysis of the dynamic stability of the model, see Freitas and Serrano (2015).
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and output, thus maintaining the optimal level of utilization.

As pointed out by Freitas and Serrano (2015) and as it is possible to deduce from the above argument, the model described does not imply a continuously fully adjusted growth path. In fact, the relevant rates of growth \( g^Z, g^Y \) and \( g^K \) are equal to each other only in the equilibrium path, while they are allowed to diverge during the disequilibrium adjustments.

While a majority of post-Keynesian and neo-Kaleckian demand-led growth models are investment-driven,\(^8\) in the supermultiplier model the long-run trend growth rate of the economy is determined by the growth path of autonomous demand. Nonetheless, a higher rate of growth of the economy still goes along with a higher equilibrium investment share, as equation 4.11 makes clear. Another way to see this important point is to borrow some Harrodian definitions. In the Harrod (1939) model, the ‘warranted rate of growth’ \( g_w \) – that equates investment and savings and implies an optimal rate of capacity utilization\(^9\) – is given by \( g_w = s/v \). In the model just presented, instead, the (endogenous) ‘supermultiplier warranted rate’ – indicated as \( g^Z^\star \) and obtained by setting \( I = S \) and \( u = u_n = 1 \), and defining \( s_i = 1 - c(1 - \tau) + m \) – can be written as

\[
g^Z^\star = \frac{s_i - Z}{v} - 1 \quad (4.12)
\]

Imagine a permanent, unexpected increase in \( g^Z \), which causes a permanent increase in the equilibrium rate of growth of aggregate demand and output. Recalling that \( s_i \) and \( v \) are exogenous, given parameters, the increase in \( g^Z \) has to be accommodated by a decrease in the ratio \( Z/Y \) and by the corresponding increase in the share of investment in output.\(^10\) We have assumed that induced investment has the task to adjust capacity. Hence, as a reaction to the initial over-utilization, prompted by the unexpected rise in the rate of growth of autonomous demand, investment will speed-up. As we can see from eq. 4.7, this implies that output will grow, for a certain span of time, at a rate higher than \( g^Z \). Once \( u = 1 \) is reached, \( Y \) and \( Z \) will grow at the same rate, but until then \( Y \) has grown more than proportionally, due to the acceleration in investment. The rate of growth of autonomous demand is now higher, but its share in output is lower. At the same time, a new, higher ‘normal’ investment share has prevailed (eq. 4.11). The

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\(^{8}\)See Lavoie (2006, ch.5) for an overview.

\(^{9}\)Harrod (1939) defines the warranted growth rate as “that rate of growth which, if it occurs, will leave all parties satisfied that they have produced neither more nor less than the right amount” (ibid., p. 16).

\(^{10}\)Note that here, when growth increases, the share of savings in output increases even if the marginal propensity to save is exogenously fixed. This is because, due to the presence of autonomous demand components, the average propensity to save differs from the marginal propensity to save (in particular, \( S/Y = s_i - Z/Y \)).
difference with the other heterodox models mentioned above lies in the causality, which in the present model goes from the rate of growth of the autonomous components to the rate of growth of demand and output, while investment is fully induced by demand growth.

### 4.2.2 Different views about the role of autonomous demand

There is, however, even among non-neoclassical authors, a certain degree of controversy regarding the relation between the autonomous components of aggregate demand and output. In Park (2000), for example, a higher rate of growth of autonomous demand leads to an equilibrium path characterized by a lower rate of output growth, due to the fact that, in the author’s words, “as the larger part of aggregate demand is used for non-capacity generating purpose, ceteris paribus, the lesser part thereof will be used for accumulating productive capacity” (ibid., pp. 9-10). It is however necessary to keep in mind that this reasoning requires the assumption of continuous normal capacity utilization, which would imply that normal capacity output determines actual output. Hence, normal capacity savings would determine the rate of accumulation compatible with keeping utilization continuously normally utilized. No independent role for aggregate demand is left and more of $Z$ causes less of $I$. Given that – in Park’s analysis – capacity has to be utilized continuously at its target level, the rate of accumulation and the rate of output growth have to coincide all the time and if the former slows down, the latter adjusts consequently.

On the contrary, in the Sraffian supermultiplier model, total demand is not bounded and an increase in $g^Z$ produces an acceleration in the process of accumulation, to endow the economy with the new productive capacity, required to produce normally the increased demand. The new equilibrium path is characterized by a rate of growth equal to the higher rate of growth of the autonomous components.

An argument similar to Park’s is advocated by Shaikh (2009), who develops an expressly Harrodian model in which autonomous components are introduced. An equation for the warranted rate is presented (ibid., p. 469), given by

$$g^Y = \left[ s_i - (G_t + X_t)/Y_t \right] u_n/v $$  \hspace{1cm} (4.13)

with $G$ equal to government spending and $X$ to exports. Equation 4.13 is analogous, in principle, to the supermultiplier warranted rate (equation 4.12, interpreting the sum of $G$ and $X$ as equivalent to $Z$). The author claims that an increase in the rate of growth of $G$ and $X$ will be expansionary or contractionary depending on the impact
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on the \((G + X)/Y\) ratio, that is to say that the equilibrium rate of growth of output will increase only if the \(Z/Y\) ratio decreases. However Shaikh considers this case to be unlikely and maintains that, usually, the increase in \(Z\) will result in a reduction in output growth, thus qualifying government spending and exports as “too much of a good thing” (ibid., p. 469). This does not happen in the supermultiplier model presented above, due to the presence of margins of unutilized productive capacity. An increase in \(g^Z\) is initially accommodated by above-normal capacity utilization. The latter increases investment, whose contribution to output growth is represented by the term \(\frac{h}{s + m - \eta}\) in equation 4.7, and for this reason \(Y\) temporarily grows more than proportionally to \(Z\) (equation 4.7). The \(Z/Y\) ratio will thus have decreased, and the investment share increased.

4.2.3 Empirical implications

On the basis of the discussion in Section 4.2.1, we can identify three hypotheses implied by supermultiplier theory that can be tested against empirical evidence:

- **H1** For any given value of the supermultiplier (SM), the trend growth rate of output converges to the trend growth rate of the autonomous components of aggregate demand (Z);
- **H2** Positive changes in \(Z\) cause positive changes in output;
- **H3** A higher growth rate of \(Z\) is associated with a higher investment share in output.

In the remainder of the paper we test these hypotheses empirically, using macroeconomic data for the US, France, Italy, Germany and Spain.

4.3 Construction of the time-series of autonomous demand and the supermultiplier

First, we need to build time-series of our variables of interest – autonomous demand (Z) and the supermultiplier (SM).

4.3.1 Autonomous demand in the national accounts

We defined \(Z\) as the sum of exports, government expenditure and autonomous consumption. Estimates of exports and government expenditure\(^{11}\) are routinely provided by national accounts. Indeed, in constructing a time-series of \(Z\), the main task is that of

\(^{11}\)With this term we refer to the sum of final consumption expenditure of general government and general government gross fixed capital formation.

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choosing an empirical counterpart for autonomous consumption ($C_0$). Autonomous (as opposed to induced) consumption is defined as that part of households consumption that is not financed out of current income. Rather, it is financed out of endogenous credit money or accumulated wealth.

For our purposes, it is appropriate to classify dwellings as durable consumption goods rather than investment goods, as they do not contribute to the expansion of productive capacity. We can thus identify two components of $C_0$: consumption spending financed by consumer credit\(^\text{12}\) and house construction financed by residential mortgage credit. With respect to the first, it appears reasonable to assume that consumption goods are purchased as soon as credit is conceded. Cars, computers, TVs and washing machines – to mention some of the most common examples – are provided to households at the moment when the credit line is opened. So we can estimate this component of $C_0$ on the basis of net flows of consumer credit.\(^\text{13}\)

Things are different in the case of residential mortgages. It would be unrealistic to assume that new houses are provided at the very moment the mortgage is approved, if only because construction takes considerable time. The flow of construction spending takes place gradually across several months (after the residential mortgage is opened or before)\(^\text{14}\). It thus appears safer to employ residential investment as our empirical measure of autonomous residential spending, under the assumption that the share of dwellings bought with cash is negligible.\(^\text{15}\)

We will thus calculate autonomous consumption in each period, when possible, as the net flow of consumer credit ($CC$) plus residential construction spending ($RES$).

\[
C_0 = CC + RES
\]

For France, Germany and Italy, where quarterly data on consumer credit ($CC$) are not available for the entire sample, we neglect this component.\(^\text{16}\) In doing this, we are...

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\(^{12}\)In principle, also consumption expenditure financed by the liquidation of accumulated wealth should be included in autonomous consumption. Unfortunately, there is no obvious way of quantifying the share of consumption financed by accumulated wealth.

\(^{13}\)We employ net inflows, rather than gross inflows, because in this way we take into account the fact that when households repay a share of previously opened debts, these fixed amounts are subtracted from current consumption independently of the current level of income, so in this sense they represent ‘negative’ autonomous spending.

\(^{14}\)Often a developer starts building a home before it is sold.

\(^{15}\)Note that in any case, even when paid by cash, dwellings are surely not financed out of current income, so in this sense they fit our definition of autonomous spending (the median price of a new home is worth several times the median yearly income in all countries).

\(^{16}\)In the case of Spain, instead, we include consumer credit in the quarterly series but not in the yearly series. We do so because in the quarterly series, which are for the period 1995:Q1-2014:Q1, consumer
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reassured by the available evidence, which suggests that consumer credit, both in the US and in Europe, has been exiguous relative to residential investment and the other components of \( Z \) (see Appendix 4.B).

### 4.3.2 The supermultiplier

Let us now turn to the task of building a proxy for the supermultiplier. Given our theoretical definitions (equation 4.6), the supermultiplier (SM) depends on the tax-adjusted propensity to consume \( (c[1−\tau]) \), the propensity to import \( (m) \) and the investment share \( (h) \). We employ the share of imports in \( GDP \) as a proxy for \( m \). Given the stylized linear consumption function, we employ \( 1 − [(C − CC)/GDP] \) (where \( C \) is total consumption, \( CC \) is credit-financed consumption and thus \( C − CC \) is total induced consumption)\(^{17}\) as a proxy for the term \( [1 − c(1 − t)] \). The investment share is simply calculated as \( I/GDP \), where \( I \) is business investment (or, equivalently, private non-housing investment). We thus compute the components of the supermultiplier as ex-post ratios of consumption, investment and imports to GDP,\(^{18}\) assuming that these ratios are useful proxies for the underlying behavioral parameters. We will use the resulting estimates of the supermultiplier only for descriptive purposes.

### 4.3.3 Sample of countries

We employ data on the US and four European countries. We try to encompass heterogeneous economic regimes and different growth strategies: the leading world economy; Germany’s export-oriented economy; France with its large public sector; a recently industrialized country like Spain; Italy’s long stagnant economy. We have built quarterly and annual time-series: 1947-2013 for the US, 1970-2013 for France, 1980-2013 for Italy and Spain, 1991-2013 for Germany. The quarterly series for the European countries are shorter than the respective yearly series: 1978:Q1-2014:Q1 for France, 1991:Q1-2014:Q1 for Germany and Italy, 1995:Q1-2014:Q1 for Spain.

\(^{17}\)In principle, if housing spending was included in \( C \) (real personal consumption expenditure) by national accounts, induced consumption would be equal to \( C − CC − RES \). However, in national accounts, housing expenditure is already excluded from \( C \), given that it is classified as investment, so we do not need to subtract it.

\(^{18}\)Of course an equation like \( M_t = m_t Y_t \), with \( m_t \) calculated as the ex-post ratio of \( M \) to \( GDP \), is just a tautology.
4.4 The dynamics of autonomous demand and output: stylized facts

4.4.1 Growth in autonomous demand and output

**United States**  Our sample period for the US (1947-2013) starts with the 1946-1949 slump, mainly due to the withdrawal of government wartime spending and the weakness of external demand (Armstrong, Glyn, and Harrison, 1991, p. 73). Recession ended in 1950, when the burst of the Korean War triggered a strong upswing led by military expenditure (ibid., pp. 106-109). Like other western economies, the US then entered a ‘Golden Age’, with GDP growing at an average annual real rate of 4.3% between 1950 and 1973. The ‘Golden Age’ was characterized by fast productivity growth, fiscal and monetary demand management policies, rising real wages, decreasing inequality and regulated financial markets. Following a ‘mini-boom’ in 1972-1973, the late Seventies and early Eighties were characterized by an evident slowdown (GDP increased by 2.3% per year between 1973 and 1983). Growth somehow rebounded since the early Eighties, before the explosion of a Great Recession in 2008-2009, followed by a relatively weak recovery (see Figure 4.2, panel b). The ‘Neoliberal cycle’ (Vercelli, 2015), experienced since the Eighties, displays opposite features with respect to the ‘Golden Age’, being characterized by market deregulation (especially in the financial sector), worsening income distribution and a reduction in the economic role of the State.

**Western Europe**  Our shorter sample periods for the European countries (1970-2013 for France, 1980-2013 for Italy and Spain, 1991-2013 for Germany) are instead almost entirely comprised in the Neoliberal Cycle. They depict, in general, a time span of similar steady and relatively moderate GDP growth, interrupted by the outburst of the Great Recession between the end of 2008 and the beginning of 2009. In the afterwards of this event, performances have diverged: Germany’s economy rebounded relatively strongly, while the French economy has stagnated and Italy and Spain have suffered most (with GDP, as of 2013, still well below its pre-crisis level in these two countries).

As it is possible to see in Figure 4.2, in all cases GDP and autonomous demand have been on a quite parallel path and their yearly rates of growth have been tightly correlated.
Figure 4.2: Autonomous Demand (Z) and Gross Domestic Product (GDP)

Source: Authors’ own elaboration on various sources
4.4.2 The structure and dynamics of autonomous demand

**United States** While its overall volume has grown steadily (at least until the mid-2000s), the composition of autonomous demand has changed substantially in time (Figure 2). The share of government spending in GDP and in Z has followed a decreasing pattern, almost perfectly compensated by the rising share of exports. The importance of residential investment has been broadly constant, although with a cyclical pattern, until the early 2000. It then displayed a relevant increase, reaching a peak in 2005-2006, followed by an even more dramatic reduction.

Overall, after the peak due to military spending in 1950-1953, the share of autonomous demand in GDP has displayed a decreasing trend until 1980, followed by a mild recovery (once again led by military spending) in the first half of the Eighties and by a broad stabilization. Note that net flows of consumer credit (which excludes mortgages) are modest with respect to the dynamics of autonomous demand. Even during the credit booms of the mid-Eighties and mid-2000s, their size was moderate with respect to the other components of autonomous demand.

**Western Europe** The overall evolution of the autonomous components of demand is characterized by an increasing trend in the Z/GDP ratio in the European countries in our sample. Export is, in general, the fastest growing component. In Germany, in particular, the share of autonomous components reaches a record amount of more than 80%, reflecting a huge increase in the openness of its economy. Also remarkable is the structural transformation that took place in Spain, after the end of Franco’s dictatorship. The definitive abandonment of protectionist policies is reflected in a sharp increase in exports. There are other interesting structural differences revealed by Figure 2: in the decade before 2008-2009, residential investment has been a dynamic and important factor in explaining the Spanish performance; France has the most active public sector, in the context of a decreasing (Germany) or stagnating (Italy) weight of Government demand. In Spain, Government expenditure was growing, in absolute terms and relative to GDP, until the end of 2007, when it entered into a severe slump, due to the application of austerity measures.

The increasing trend of the Z/GDP ratio in the European countries, which is the result of GDP growing slower than autonomous demand, can be explained in terms of a decreasing supermultiplier, a factor that dampens the impact on GDP of variations in autonomous demand; of course, the discrepancy between the growth rates of Z and Y is larger where the supermultiplier has fallen more (see Figure 4.3).
Having presented these series, a clarification is in order. Given the magnitudes involved, it may appear of little sense to study the relationship between the total (GDP) and a very big part of it (Z). However, it is important to note that the ratio Z/Y does not correspond to the net contribution of Z to GDP. Part of autonomous demand is devoted to foreign production, as taken into account by the presence of m in the denominator of the supermultiplier. Hence, the fact that the Z/Y ratio is, for example, 50%, does not mean that 50% of GDP is produced to fulfill autonomous demand.19

19From the accounting identity $Y = C + I + Z - M$, we can see that $Y + M = C + I + Z$, which makes clear that Z is not a net component of GDP.
4.4. Stylized facts

Figure 4.3: Autonomous components of aggregate demand

Source: Authors’ own elaboration on various sources

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4.4.3 The supermultiplier

It is interesting to notice that, throughout the entire period in which comparable data are available, the SM has been clearly higher in the US than in the European countries (Figure 4.4). This mainly reflects lower propensities to import and to save. At the beginning of our sample period, the Spanish supermultiplier was roughly in line with that of the US; nonetheless, the democratic transition was accompanied by a relevant and prolonged increase in the degree of openness of the Spanish economy. This brought Spain’s supermultiplier in line with that of the other Western European countries very rapidly.

**United States** The supermultiplier (SM) was at an extremely high level in 1947, due to a peak in the propensity to consume - most probably because families were eager to spend savings accumulated during the war. As this effect faded away, the propensity to consume and the supermultiplier fell steeply between 1947 and 1951. Since the Sixties, the SM has remained broadly stable. After 1975, its dynamics has been the result of two opposite tendencies: a decreasing propensity to save (at least until 2007-2008) and an increasing propensity to import. The result has been overall stability, with a mildly decreasing trend in the last two decades (Figure 4.5, panels (a) and (b)).

**Western Europe** A generalized increase in the propensity to import is the main factor behind the decrease in the supermultiplier experienced by the four countries in the years before the outburst of the recent financial crisis.

For what concerns the German case, the reduction in the supermultiplier has been strengthened by a rising propensity to save, prompted by an improving external balance (Cesaratto, 2012). In France and Italy, the propensities to save have displayed instead a more stable long-run pattern, although with cyclical fluctuations. The same can be maintained for Spain, with the exception of the first years of the sample (1980-1984), which displayed a relevant enlargement of the fraction of income saved by households.

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20The inclusion of consumer credit (CC) in the US leads to a small underestimation of the difference between the US supermultiplier and those of the European countries. Indeed, the US propensity to save – which we computed as \[1 - (C - CC)/GDP\], where C is total household consumption – is increased by the presence of CC and, accordingly, the SM is reduced.

21In his speech on the State of the Union, delivered in Jan.1946, President Truman stated that “On the expenditure side (...), consumers budgets, restricted during the war, have increased substantially as a result of the fact that scarce goods are beginning to appear on the market and wartime restraints are disappearing. Thus, consumers current savings are decreasing substantially from the extraordinary high wartime rate and some wartime savings are beginning to be used for long-delayed purchases” (Truman, 1946).
It is worth noting the remarkable stability of the investment share, which can be interpreted as a sign of an average degree of utilization near to the normal one.

Table 4.1 summarizes some major aspects of these historical dynamics, displaying average growth rates of output, autonomous demand and supermultiplier. Changes in Z and SM are decomposed in the contributions of each component. If we interpret this as an alternative form of ‘growth accounting’ – based on effective demand instead of factors’ supply – we can infer from this exercise that in the US long-run changes in output are mainly accounted for by the growth of demand, while changes in the supermultiplier have been relatively less important (especially since 1960). In the European countries, instead, the strong decreasing trend in the supermultiplier has played a significant role, which results in greater discrepancies between the growth rates of autonomous demand and output.
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Figure 4.5: Supermultiplier
(m and h on the left axis, s on the right axis; Italy, 1980-2013; Spain 1980-2013)

SM = supermultiplier; m = propensity to import; h = propensity to invest; s = propensity to save;

Source: Authors’ own elaboration on various sources
4.5 Autonomous demand and output: long-run relation

Table 4.1: Average annual growth of GDP, Z and SM

<table>
<thead>
<tr>
<th></th>
<th>GDP</th>
<th>Z</th>
<th>RES</th>
<th>CC</th>
<th>G</th>
<th>X</th>
<th>SM</th>
<th>s</th>
<th>m</th>
<th>h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.5%</td>
<td>0.0%</td>
<td>4.5%</td>
<td>0.1%</td>
<td>-0.7%</td>
<td>-0.5%</td>
<td>-0.3%</td>
<td>0.0%</td>
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<td>United States</td>
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<tr>
<td>'47-'60</td>
<td>3.7%</td>
<td>4.9%</td>
<td>0.5%</td>
<td>0.0%</td>
<td>4.5%</td>
<td>0.1%</td>
<td>-0.7%</td>
<td>-0.5%</td>
<td>-0.3%</td>
<td>0.0%</td>
</tr>
<tr>
<td>'60-'78</td>
<td>4.0%</td>
<td>3.4%</td>
<td>0.6%</td>
<td>0.2%</td>
<td>1.8%</td>
<td>0.6%</td>
<td>0.0%</td>
<td>0.3%</td>
<td>-0.7%</td>
<td>0.5%</td>
</tr>
<tr>
<td>'78-'91</td>
<td>2.8%</td>
<td>2.5%</td>
<td>-0.1%</td>
<td>-0.3%</td>
<td>2.0%</td>
<td>1.0%</td>
<td>-0.4%</td>
<td>0.3%</td>
<td>-0.3%</td>
<td>-0.4%</td>
</tr>
<tr>
<td>'91-'13</td>
<td>2.6%</td>
<td>2.5%</td>
<td>0.2%</td>
<td>0.0%</td>
<td>0.7%</td>
<td>1.4%</td>
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<td>France</td>
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<tr>
<td>'70-'80</td>
<td>3.7%</td>
<td>4.9%</td>
<td>0.5%</td>
<td>-</td>
<td>2.3%</td>
<td>2.0%</td>
<td>-0.9%</td>
<td>0.1%</td>
<td>-0.9%</td>
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</tr>
<tr>
<td>'80-'91</td>
<td>2.3%</td>
<td>2.9%</td>
<td>-0.1%</td>
<td>-</td>
<td>1.6%</td>
<td>1.4%</td>
<td>-0.4%</td>
<td>0.0%</td>
<td>-0.6%</td>
<td>0.2%</td>
</tr>
<tr>
<td>'91-'13</td>
<td>1.5%</td>
<td>2.4%</td>
<td>0.0%</td>
<td>-</td>
<td>0.7%</td>
<td>1.7%</td>
<td>-0.9%</td>
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<td>Germany</td>
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<tr>
<td>'91-'13</td>
<td>1.3%</td>
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<td>0.4%</td>
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<td>Italy</td>
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</tr>
<tr>
<td>'80-'91</td>
<td>2.3%</td>
<td>2.9%</td>
<td>0.1%</td>
<td>-</td>
<td>1.4%</td>
<td>1.4%</td>
<td>-0.5%</td>
<td>0.4%</td>
<td>-0.9%</td>
<td>0.1%</td>
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<tr>
<td>'91-'13</td>
<td>0.6%</td>
<td>1.6%</td>
<td>0.0%</td>
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<td>0.1%</td>
<td>1.7%</td>
<td>-1.0%</td>
<td>-0.1%</td>
<td>-0.8%</td>
<td>-0.1%</td>
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<tr>
<td>Spain</td>
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<td></td>
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</tr>
<tr>
<td>'80-'91</td>
<td>2.9%</td>
<td>5.3%</td>
<td>0.4%</td>
<td>-</td>
<td>2.8%</td>
<td>2.2%</td>
<td>-2.0%</td>
<td>-0.7%</td>
<td>-1.8%</td>
<td>0.6%</td>
</tr>
<tr>
<td>'91-'13</td>
<td>2.0%</td>
<td>4.1%</td>
<td>0.3%</td>
<td>-</td>
<td>0.9%</td>
<td>2.9%</td>
<td>-2.0%</td>
<td>-0.2%</td>
<td>-1.5%</td>
<td>-0.3%</td>
</tr>
</tbody>
</table>

Note: contributions may not sum up precisely to the growth rate of the aggregate due to rounding and approximation.

4.5 Autonomous demand and output: long-run relation

4.5.1 Economic growth and autonomous demand across countries and decades

As a first step, we look at the long-run relation between GDP and autonomous demand (Z). We compute (approximately) 10-year\textsuperscript{22} average changes in GDP and in Z in our sample of five countries. We then regress GDP growth rates on percentage changes in Z. The relation is tight and highly significant. On average, a 1% increase in autonomous demand is associated with a 0.67% increase in GDP. Changes in Z explain 88% of variability in GDP growth (Figure 4.6).

Of course, one must be cautious in interpreting this result in terms of a causal effect.

\textsuperscript{22}Not in all cases the changes are taken exactly over 10-year periods. More specifically, we computed average changes over the following periods: 47-60, 60-70, 70-80, 80-90, 90-00, 00-07, 07-13 for the US; 80-90,90-00, 00-07, 07-13 for Italy and Spain; 70-80, 80-90, 90-00, 00-07, 07-13 for France; 91-00, 00-07, 07-13 for Germany.

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of Z on GDP. In fact it is not guaranteed that changes in autonomous demand are completely exogenous. There could be reverse causality (a positive effect of GDP on autonomous demand), or both changes in output and autonomous demand could be driven by some other factor. Note also that, if some component of Z is to some extent negatively influenced by GDP (as may be the case, in some instances, for government spending and/or exports), this would cause a downwards bias in our estimate of the effect of Z on GDP.

4.5.2 Cointegration tests

Another way to look at the long-run relation between Z and GDP is to apply cointegration analysis (Engle and Granger, 1987), to test whether the two variables share a common long-run trend (as stated by H1, in Section 4.2.3).

In order to perform this analysis, we construct the longest possible quarterly time-series, given data availability (1946:Q1-2014:Q1 for the US; 1978:Q1-2014:Q1 for France; 1991:Q1-2014:Q1 for Germany and Italy; 1995:Q1-2014:Q1 for Spain).

A complication arises, however, in performing cointegration tests on our sample period. The simple theoretical model, derived in Section 4.2.1, was built under the assumption of constancy of the marginal propensities to save and to import. Nonetheless, the supermultiplier has displayed a strong decreasing trend, in the European countries
in our sample, during the whole period under observation (Figures 4.5 and 4.4), due to an upward trend in the propensity to save \((s)\) and, more importantly, in the propensity to import \((m)\). We thus need to adjust the model, relaxing the mentioned assumption, to appreciate the theoretical implications of these relevant changes. With a time-varying SM, equation 4.7 becomes

\[
g^Y = g^Z + g^{SM} + g^Z g^{SM} \tag{4.15}
\]

which implies \(g^Y - g^Z = g^{SM} + g^Z g^{SM}\), where \(g^{SM}\) is the rate of growth of the supermultiplier. This makes clear that, according to the theory, \(Y\) and \(Z\) are cointegrated (i.e., \(g^Y = g^Z\)) only when \(g^{SM} = 0\) and that the discrepancy between the trend growth rates of \(Y\) and \(Z\) is a positive function of the change in SM.\(^{23}\)

In other words, output and autonomous demand move in step as long as the supermultiplier is constant. Otherwise, the impact of variations in \(Z\) is amplified or dampened by the change in SM.

Visual inspection of Figure 4.2 strongly suggest that both GDP and \(Z\) are I(1) processes (i.e., they are non-stationary in levels but stationary in first-differences). This is confirmed by ADF unit-root tests (Dickey and Fuller, 1979). On the basis of the above discussion, we expect GDP to be cointegrated with \(Z\) for countries and periods in which the supermultiplier (SM) is stable enough.

To test for cointegration, we perform a Johansen cointegration test (Johansen, 1988, 1991), based on a model with a constant trend and two lags\(^{24}\), on the natural logarithms of \(Z\) and GDP. The null hypothesis of no cointegration is rejected at the 95% confidence level only for the US, while it cannot be rejected at any conventional level for the four European countries. This is consistent with the descriptive evidence displayed by Figures 4.5 and 4.4, which suggest that the supermultiplier was indeed broadly stable in the US (except for some fluctuations in the very beginning of the sample), while it had a neat and strong decreasing trend in the four European countries.

In order to get a taste of the stability of the cointegration relation found in US data, we plot the residuals from a regression of GDP on \(Z\) (Figure 4.7). The result is not

\(^{23}\)Of course, we are ruling out the case in which \(g^Z \leq -1\), which makes little economic sense.

\(^{24}\)Inclusion of a constant trend is suggested by visual inspection of the data. In order to select the lag order, we estimated a VAR in levels including \(Z\) and GDP and computed several standard information criteria. Schwarz's Bayesian information criterion (BIC), Akaike's information criterion (AIC) and Hannan-Quinn information criterion (HQIC) all point to the inclusion of two lags. As shown by Nielsen (2006), these tests are valid even in the presence of I(1) variables. As a robustness test, we run the Johansen test with any possible number of lags between 1 and 16. In all cases results are unchanged: the null is rejected for the US but not for European countries.
4. Autonomous demand, growth and investment

-4
-3
-2
-1
0
1
2
3
4
1947
1951
1956
1960
1965
1969
1974
1978
1983
1987
1992
1996
2001
2005
2010

Figure 4.7: Standardized residuals from a regression of ln(GDP) on ln(Z) (US, quarterly data, 1947:Q1 - 2014:Q1)

exactly what we would expect from a stable cointegration relation: it appears clear that the relation between Z and GDP underwent a major change in the very first years of the sample. In particular, if we accept provisionally the hypothesis that the cointegration relation is due to a long-run causal effect of Z on Y, the pattern of residuals would suggest that the elasticity of Y with respect to Z was much higher in the 1947-1950 period, and then decreased substantially. According to theory, this should be the result of the initial reduction in the supermultiplier.

Table 4.2: Johansen test, trace statistics for the null hypothesis of no cointegration between Z and GDP

<table>
<thead>
<tr>
<th></th>
<th>USA</th>
<th>Germany</th>
<th>France</th>
<th>Italy</th>
<th>Spain</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H_0$</td>
<td>18.7∗∗</td>
<td>9.9</td>
<td>6.7</td>
<td>6</td>
<td>12.3</td>
</tr>
<tr>
<td>$N$</td>
<td>267</td>
<td>91</td>
<td>143</td>
<td>91</td>
<td>75</td>
</tr>
<tr>
<td>’47:Q3-’14:Q1</td>
<td>’91:Q3-’14:Q1</td>
<td>’78:Q3-’14:Q1</td>
<td>’91:Q3-’14:Q1</td>
<td>’95:Q1-’14:Q1</td>
<td></td>
</tr>
</tbody>
</table>

Notes: 2 lags of each variable and an unrestricted constant included in the underlying VAR model; ∗, ∗∗ and ∗∗∗ denote rejection of the null hypothesis of no cointegration at the 0.10, 0.05 and 0.01 significance levels respectively.

Summing up, in our sample we have a situation which approximates reasonably well the case of $g_{SM} = 0$ only in the US in the period after the Fifties. Only in this case there is a stable long-run relation between Z and GDP, confirmed by cointegration tests. In the European countries, in which SM displays a clear decreasing trend, GDP growth has lagged behind the growth of Z.

It would be useful to test more formally whether the discrepancies between the
long-run trends of Z and GDP, in the European countries, are actually caused by the declining trend of the SM. The most natural way to do this would be to include SM in the cointegration equation and check whether this yields a stable long-run relation or, alternatively, to correct Z by multiplying it for SM. The problem with these solutions is that they would produce a stable cointegration relation by definition. In our data \( Y_t = Z_t \cdot SM_t \) holds by construction, due to the fact that we calculated the SM components as ex-post ratios of consumption, investment and imports to GDP.\(^{25}\) Of course, when we introduce SM in the cointegration equation in the two ways just mentioned, we obtain a stable cointegration relation in all countries, but the result has no explanatory meaning. One could try to build some proxy for the supermultiplier in order to break the accounting identity (for example employing the household saving rate, corrected for an average taxation rate, instead of the actual overall marginal propensity to save). But the dilemma would not be solved at all: a good proxy for SM is closely correlated with actual SM, so our estimated cointegration relation would remain very close to an accounting identity.

In the remaining of this section we exploit the period of stability of the supermultiplier, in the US since the Sixties - which results in cointegration between output and autonomous demand - to study the properties of the cointegration system. In particular, the estimation of a Vector Error-Correction model (VECM) allows us to assess the direction of short and long-run causality.

### 4.5.3 Short-run impacts, long-run impacts and direction of causality: an error-correction model for the US economy

In order to assess short and long-run relations and try to identify the direction of causality, we estimate the parameters of a bivariate Vector Error-Correction model (VECM), using US quarterly data on \( Z \) and on GDP for the period 1960:Q1-2014:Q1.\(^{26}\) We include a constant trend and a two-lags order structure. Assuming a long-run equilibrium relation of the type\(^{27}\)

\[ GDP_t = c_1 + \theta_1 Z_t + c_2 D + \theta_2 D Z_t + \epsilon_t, \]

where \( D \) is a dummy equal to 1 if \( t > 1960:Q1 \) and 0 otherwise. Both \( c_2 \) and \( \theta_2 \) are significant at the 0.0001 significance level. After 1960, the overall constant term passes from around 3 to 0, while the coefficient on \( Z \) increases from 0.6 to around 1.

\(^{25}\)Changes in inventories, which we did not include in the analysis, and possibly a statistical discrepancy between expenditure side and output side measurement of GDP, prevent our measure of \( Z \cdot SM \) to be exactly equal to GDP.

\(^{26}\)As discussed in the previous subsection, we restrict the analysis to the period during which the supermultiplier was broadly stable (see Figure 4.5 panel (a)). Besides being strongly suggested by visual inspection of Figure 4.7, our hypothesis of a break in the cointegrating relation in 1960 is supported by a simple formal test: we estimate equation \( GDP_t = c_1 + \theta_1 Z_t + c_2 D + \theta_2 D Z_t + \epsilon_t, \) where \( D \) is a dummy equal to 1 if \( t > 1960:Q1 \) and 0 otherwise. Both \( c_2 \) and \( \theta_2 \) are significant at the 0.0001 significance level. After 1960, the overall constant term passes from around 3 to 0, while the coefficient on \( Z \) increases from 0.6 to around 1.

\(^{27}\)One obtains eq. 4.16 by normalizing the cointegrating vector w.r.t. GDP.
Chapter 4. Autonomous demand, growth and investment

\[ GDP_t = c + \Theta Z_t \]  

(4.16)

we model empirically the short-run adjustment process through the following VECM:

\[ \Delta GDP_t = \alpha_0 + \alpha_1 (GDP_{t-1} - \Theta Z_{t-1} - c + \mu) + \alpha_2 \Delta GDP_{t-1} + \alpha_3 \Delta Z_{t-1} + e_{1t} \]  

(4.17)

\[ \Delta Z_t = \gamma_0 + \gamma_1 (GDP_{t-1} - \Theta Z_{t-1} - c + \mu) + \gamma_2 \Delta Z_{t-1} + \gamma_3 \Delta GDP_{t-1} + e_{2t} \]  

(4.18)

where \( Z \) is the log of real autonomous demand and \( GDP \) is the log of real GDP. Supermultiplier theory implies that, given the stability of the SM, we should have the following:

(a) \( \epsilon_t = GDP_t - Z_t - c \) is a stationary series

(b) \( \Theta = 1 \)

(c) \( \alpha_1 < 0 \)

(d) \( \gamma_1 = 0 \)

(e) \( \alpha_3 > 0 \)

Condition (a) ensures that autonomous demand and output share a common long-run trend. We have already verified that through the Johansen cointegration test. Condition (b) means that \( Z \) and GDP move in step in the long-run. The most important restrictions are (c) and (d): taken together, they imply that long-run causality goes from \( Z \) to GDP and not vice-versa. Finally, (e) means that autonomous demand has a positive short-run multiplier effect.

Results are presented in Table 4.3, column (1). The estimated long-run coefficient \( \Theta \) is very close to one (1.04). The error-correction term in the equation explaining \( \Delta GDP \) (\( \alpha_1 \)) is negative and significant at the 95% confidence level, but also the adjustment term explaining \( \Delta Z \) (\( \gamma_1 \)) is significant, even if only at the 90% confidence level. For what concerns short-period coefficients, \( \Delta Z_{t-1} \) has a positive but low effect on \( \Delta GDP \), while the impact of lagged output changes on \( \Delta Z \) appears higher.

Consumer credit is likely to be the element which is most influenced by the economic cycle (see discussion below). We thus try to re-estimate our VECM, after subtracting this component from \( Z \). Results – reported in Table 4.3, column 2 – are more in line with the predictions of supermultiplier theory. \( \alpha_1 \) is negative and significant, while \( \gamma_1 \) is
not significantly different from zero: when GDP and Z are in disequilibrium, it is GDP that adjusts to the equilibrium relation. This result – coupled with the fact that $R^2$ is much higher for equation 4.17 than for equation 4.18 – is supportive of the hypothesis that autonomous demand drives output in the long-run. The short-run impact of Z on output becomes higher, while the elasticity of autonomous demand to short-run changes in output strongly decreases, from 0.7 to 0.3. In any case, also after excluding consumer credit from Z, the short-run effect of output changes on autonomous demand remains significant, suggesting that also the other components of Z are somehow influenced by GDP growth.

We can appreciate the dynamics of the estimated model by calculating orthogonalized impulse-response functions (OIRFs). A positive shock to autonomous demand has a permanent but low effect on output (left panel). At the same time, an increase in output has a positive and persistent, but even lower, effect on autonomous demand (Figure 4.8).

What emerges clearly from these results is the presence of a mutual influence between autonomous demand and output. In spite of having classified Z as the autonomous components of demand, by definition independent from the actual or expected level of aggregate demand and output, the empirical evidence shows that causality runs not only from Z to Y, as expected, but also from Y to Z.

It has to be specified that, in the Sraffian-Keynesian growth model that we summarized in Sec.4.2, the fact that Z is autonomous means that it is not determined by output through a necessary functional relation. Even so, Z does not fall from the sky: it is socially and historically determined; among the various social and economic factors that influence autonomous spending, economic growth certainly plays a major role. We can indeed imagine several plausible explanations for this mutual influence.

There are solid theoretical reasons to explain a strong endogeneity of consumer credit. The evolution of output is likely to influence both demand and supply for credit, given that appetite for risk is pro-cyclical (Minsky, 1982).

As we have shown, when consumer credit is excluded from autonomous demand the endogeneity of Z is significantly reduced but certainly not eliminated. Also the other

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28In order to obtain the OIRF we have to impose an identification restriction on the underlying structural model. We choose to employ a Cholesky decomposition, assuming that Z is ‘causally prior’ to GDP. That means that GDP growth can be affected by contemporaneous and lagged autonomous changes in Z, while Z can be affected by lagged autonomous changes in GDP, but not by contemporaneous ones. This restriction appears the most sensible one: changes in Z are bound to have a contemporaneous effect on output growth, since Z shares some components with GDP. To the contrary, Z is composed by autonomous variables that are discretionally determined by individuals and institutions. When choices influencing Z are made (government budget choices, house purchases, foreign citizens’ spending, etc.) the individuals and institutions involved can possibly observe estimates of growth in the preceding quarters, but they cannot observe unexpected changes in GDP that will happen in the same quarter.
Figure 4.8: Orthogonalized impulse response functions (OIRFs) and bootstrapped 90% confidence intervals

(US, quarterly data, 1960:Q1 - 2014:Q1; Z*=Z-CC)
components of autonomous demand, in other words, are sensitive to output growth. For what concerns exports, it can be argued that output growth increases a country’s productivity – a fact known as Verdoorn’s law (Verdoorn, 1949) – enhancing in this way external competitiveness and thus stimulating exports (Dixon and Thirlwall, 1975). Moreover, international business cycle synchronization (Baxter and Kouparitsas, 2005; Cerqueira, 2013) may provide a further channel of mutual influence. In particular, income growth in the US, one of the main engines of worldwide demand, may have positive spillovers on trade partners, boosting their income and their demand for imports from the US. Regarding the behavior of public expenditures, various authors have noticed their endogeneity with respect to macroeconomic conditions (see for example Kelton, 2016). The direction of this effect is somehow ambiguous: fiscal policy is potentially stabilizing (Kelton, 2016; Krugman, 2009), but in several cases it has been found to be procyclical (Frankel, 2012; Sørensen, Wu, and Yosha, 2001). What matters for our analysis, in any case, is that public spending is certainly influenced by output growth. This does not imply that fiscal policy is not discretionary, even when governments follow peculiar fiscal rules (themselves completely discretionary too), but means that the path of public expenditure, even if autonomous, is not abstract from reality and necessarily responds to the economic and political context and objectives of a country. A last
possible channel of influence has to do with the specific proxy we used for one of the components of autonomous consumption, namely residential investment, which tends to be positively affected by GDP growth (Arestis and González-Martínez, 2015).

Notwithstanding these feedback effects, it is worth remarking that, after consumer credit is excluded from autonomous demand, our tests indicate that long-run causality goes univocally from autonomous demand to output.

A further remark is also in order. While all our results point to some long-run impact of Z on GDP, the orthogonalized impulse responses (depicted in Figure 4.8) imply a rather low short-run multiplier. The resulting 4-years cumulative multiplier, for example, is just around 0.45, on the lower bound of the existing empirical literature on fiscal multipliers. Informed by the latter, we think that our low short-run multipliers are probably due to the extreme difficulty of identifying truly exogenous demand shocks from our extremely simplified two-way VECM model. Estimating with more precision the short-run multiplier effect of Z – exploiting also the information contained in the time-series for the European countries - is the scope of the next Section.

4.6 The multiplier of autonomous demand

The most straightforward way to assess the short-run multiplier effect of autonomous demand on output would be to estimate an equation of the type

\[ \Delta GDP_{c,t} = \mu_c + \sum_{i=1}^{m} \alpha_i \Delta GDP_{c,t-i} + \sum_{j=0}^{n} \beta_j \Delta Z_{c,t-j} + \epsilon_{c,t} \]  

where \( c \) indicates the country and \( \mu_c \) are country-specific fixed effects.

However, the \( \beta_s \) estimated from this specification would suffer from endogeneity. Indeed, when studying the US case, we found strong mutual causality in the short-run feedback effects. In- 

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However, the \( \beta_s \) estimated from this specification would suffer from endogeneity. Indeed, when studying the US case, we found strong mutual causality in the short-run

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29 Our OIRFs can be interpreted as elasticities (given that we take variables in natural logarithms), so the multiplier at a given time horizon is simply the impulse-response divided by the ratio \( Z/Y \).

30 See Spilimbergo, Symansky, and Schindler, 2009 for precise definitions of multipliers and cumulative multipliers.

31 See for example the review in Summers and DeLong (2012, pp. 244-246)

32 As well-known, the inclusion of both country fixed effects and autoregressive dynamics generates a bias (Nickell, 1981). However this bias is of order \( 1/T \), so it is negligible in panels with large \( T \). In general the literature tends to favor the use of FE estimators in panels with small \( N \) and large \( T \) (Kennedy, 2013, p. 291). In our case, \( N \) is small and \( T \) is relatively large (on average we have 32 observations per country). In any case, the resulting distortion is a downwards bias, so it renders our estimates of the multiplier of \( Z \) more conservative. Furthermore, we will show below that employing the TSLS pooled estimator (which is biased upwards) and the Arellano-Bond GMM estimator (which is unbiased but less efficient with large \( T \)) does not alter results.
4.6. The multiplier of autonomous demand

between $Z$ and GDP. Moreover, it is widely acknowledged in the empirical literature on fiscal multipliers (see for example Nakamura and Steinsson, 2014; Ramey, 2011) that Government spending, a major component of autonomous demand, tends to react to the economic cycle.

To tackle endogeneity, we estimate equation 4.19 through two-stages least squares (2SLS). We include observations from all five countries in our sample using annual data\textsuperscript{33} and set $m = n = 2$.\textsuperscript{34} As instrumental variables for $Z$ we employ military expenditure, US economic growth (for European countries) and an index\textsuperscript{35} which measures trade restrictions imposed by Mexico and Canada (for the US).\textsuperscript{36} These are important determinants of exports and government spending (the two major components of $Z$), which are plausibly exogenous with respect to a country’s economic cycle.

Military expenditure is widely used as an instrument for $G$ in the empirical literature (e.g., Nakamura and Steinsson, 2014), since it is largely unrelated to short-run output fluctuations. US growth is surely an important exogenous determinant of demand for European exports, under the plausible identifying assumption that, in the short-term, the dynamics of US output is not determined by the growth rate of European economies. Conversely, we do not employ European growth as an instrument for US autonomous demand because the US economy is likely to exert a considerable influence on it (so the instrument would not be exogenous). Instead, we employ an index of trade restrictions imposed by Mexico and Canada, by far the two most important destinations of US exports.

The first stage of the estimation indicates that our instruments are relevant. The $F$-statistic on the excluded instruments and the Anderson canonical correlation test are highly significant (with $p < 0.00001$ in both cases) and the partial $R^2$ of the first-stage regression is 22%. Sargan (1958) and Basmann (1960) tests of overidentifying restrictions suggest that the instruments are also valid (i.e. exogenous).

We find $\alpha_1$ and $\beta_0$ to be statistically significant at the 1% confidence level, while $\alpha_2$, $\beta_1$ and $\beta_2$ are not significantly different from zero at any conventional level. Country-specific effects are jointly significant. We employ estimation results to track the short-run

\textsuperscript{33}Most of the instruments that we employ are available only at yearly frequencies.

\textsuperscript{34}We choose the lag-length on the basis of conventional information criteria, inspection of correlation and autocorrelation functions and statistical significance.

\textsuperscript{35}In particular we used a component of the KOF Index of Globalization (Dreher, Gaston, and Martens, 2008). See Appendix 4.A.

\textsuperscript{36}We have considered also several other possible instruments, like for example population growth, expenditures caused by natural disasters, households’ debt stock and the IMF narrative index of deficit-driven fiscal consolidations (Guajardo and Pescatori, 2014) but they resulted endogenous (in the case of population growth) or not-relevant.
Chapter 4. Autonomous demand, growth and investment

effect of a unit increase in Z (i.e. the multiplier of Z). The impact multiplier is 1.3. The cumulative 4-year multiplier is 1.6. In other words, a one-Dollar (or Euro) increase in autonomous demand raises output by 1.3 dollars over the first year and by 1.6 dollars over four years (Figure 4.9).\(^{37}\)

As robustness tests, we re-estimate equation 4.19 using a pooled 2SLS estimator (which excludes fixed-effects), difference-GMM and system-GMM. Results remain qualitatively analogous to those produced by the within-groups estimator: when using the pooled 2SLS, the impact multiplier decreases to 1.1 but the 4-years cumulated multiplier rises to 1.7; when using difference-GMM the impact multiplier is 1.1 and the 4-years cumulated multiplier 1.2; when using system-GMM the impact multiplier is 1.1 and the 4-years cumulated multiplier 1.7.

\(\begin{align*}
\text{Figure 4.9: Short-run multiplier of Z} \\
\text{(2SLS fixed-effects model, yearly data, all five countries)}
\end{align*}\)

4.7 Autonomous demand and the investment share

Let us now assess whether increases in the rate of growth of autonomous demand tend to cause increases in the investment share, as supermultiplier theory would predict (hypothesis \(H3\), as stated in Section 4.2.3). Figure 4.10 displays the relation between lagged

\(^{37}\)Impulse responses (IRs), calculated from the estimated model, can be interpreted as elasticities (given that we take variables in natural logarithms), so the multiplier at a given time horizon is simply the IR divided by the ratio \(Z/Y\). For the definitions of \(n\)-year multiplier and cumulative multiplier see Spilimbergo, Symansky, and Schindler (2009).
4.7. Autonomous demand and the investment share

changes in \( Z \) and changes in the investment share at a quarterly frequency in our sample of countries, highlighting a positive relation, which suggests that indeed the rate of change of \( I/Y \) is positive function of \( g^Z \).

In order to test \( H3 \) more formally, we perform Granger causality tests.\(^{38} \) For each country, we employ Ordinary Least Squares (OLS) to estimate the parameters of the following equations

\[
\Delta I_t = \alpha_0 + \sum_{i=1}^n \alpha_i \Delta I_{t-i} + \sum_{j=1}^n \beta_j \Delta Z_{t-j} + \epsilon_{I,t} \tag{4.20}
\]

\[
\Delta Z_t = \gamma_0 + \sum_{i=1}^n \gamma_i \Delta Z_{t-i} + \sum_{j=1}^n \delta_j \Delta I_{t-j} + \epsilon_{Z,t} \tag{4.21}
\]

where \( I \) is the log of the investment share (\( I/GDP \cdot 100 \)) and \( Z \) is the log of autonomous demand, with the order of lags (\( n = 2 \)) selected by the usual criteria. We can then calculate F-statistics testing the null hypotheses of non Granger-causality, which are respectively

\[
H_{0a} : \beta_1 = \beta_2 = 0 \quad \text{and} \quad H_{0b} : \delta_1 = \delta_2 = 0
\]

Results (Table 4.4) confirm the indications of Figure 4.10. Positive changes in autonomous demand predict positive changes in the investment share, as predicted by supermultiplier theory. The null hypothesis that autonomous demand does not Granger-cause the investment share (\( H_{0a} \) above) is rejected for all five countries at the 95% confidence level. In the case of the US, we perform the Granger-causality test both in the whole sample and in the 1960-2014 subsample, rejecting the null of no-Granger causality in both cases (at the 0.05 significance level in the whole sample and at the 0.001 level in the 1960-2014 subsample).

We can use the estimated coefficients to calculate the implied long-run effect of autonomous demand growth on changes in the investment share, according to the formula

\[
\frac{\beta_1 + \beta_2}{1 - \alpha_1 - \alpha_2} \tag{4.39}
\]

Long-run effects for each country are reported in Table 4.4. For the US the impact is equal to 0.33 (with a p-value of 0.008) for the whole sample and to 0.63 (\( p < 0.000 \)) for the sub-period 1960-2014. In European countries the estimated impact

\[^{38}\text{A Granger causality test is useful in identifying lead-and-lag relationships between time-series. The variable X causes the variable Y, in the sense of Granger, if past values of X contain useful information to predict the present value of Y. Formally, X Granger-causes Y if } E(y_t | y_{t-1}, y_{t-2}, \cdots, x_{t-1}, x_{t-2}, \cdots) \neq E(y_t | y_{t-1}, y_{t-2}, \cdots).\]

\[^{39}\text{Note that we are imposing the constraint that the simultaneous effect of } g^Z \text{ is zero, by definition of Granger causality. In this sense our estimate of the long-run effect can be considered prudential.}\]
is 0.77 in Germany, 0.90 for France, 0.95 for Italy and 0.69 in the Spanish data (all being significant at the 0.01 significance level).

Is there some feedback effect of the investment share on autonomous demand? We would expect so, given that investment exerts a multiplier effect on output, and in turn the latter has been found in previous tests to positively affect autonomous demand. However the investment share Granger-causes autonomous demand with a positive (but rather low) coefficient in the cases of France and Italy but not in the other countries, as shown in Table 4.4 (also in the case of the US in the whole sample \( I/Y \) appears to Granger-cause \( Z \), however the estimated coefficient is negative).

Table 4.4: Granger-causality test between autonomous demand and the investment share

<table>
<thead>
<tr>
<th>Test for Granger-causality from ( \Delta Z ) to ( \Delta I ) (eq. 4.20)</th>
<th>US</th>
<th>US*</th>
<th>GER</th>
<th>FRA</th>
<th>ITA</th>
<th>SPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-stat (( H_{0a} : \beta_1 = \beta_2 = 0 ))</td>
<td>3.78***</td>
<td>7.37***</td>
<td>10.66***</td>
<td>4.05**</td>
<td>7.08***</td>
<td>3.77**</td>
</tr>
<tr>
<td>impact</td>
<td>0.33***</td>
<td>0.63***</td>
<td>0.77***</td>
<td>0.90***</td>
<td>0.95***</td>
<td>0.69***</td>
</tr>
<tr>
<td></td>
<td>(0.12)</td>
<td>(0.18)</td>
<td>(0.14)</td>
<td>(0.34)</td>
<td>(0.26)</td>
<td>(0.24)</td>
</tr>
<tr>
<td>Adj. ( R^2 )</td>
<td>0.10</td>
<td>0.27</td>
<td>0.21</td>
<td>0.05</td>
<td>0.12</td>
<td>0.05</td>
</tr>
<tr>
<td>Obs.</td>
<td>266</td>
<td>217</td>
<td>90</td>
<td>142</td>
<td>90</td>
<td>74</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test for Granger-causality from ( \Delta I ) to ( \Delta Z ) (eq. 4.21)</th>
<th>US</th>
<th>US*</th>
<th>GER</th>
<th>FRA</th>
<th>ITA</th>
<th>SPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-stat (( H_{0b} : \delta_1 = \delta_2 = 0 ))</td>
<td>5.71***</td>
<td>1.99</td>
<td>0.15</td>
<td>3.53**</td>
<td>5.43***</td>
<td>0.24</td>
</tr>
<tr>
<td>impact</td>
<td>-0.31***</td>
<td>-0.14</td>
<td>0.006</td>
<td>0.16***</td>
<td>0.21**</td>
<td>0.07</td>
</tr>
<tr>
<td></td>
<td>(0.10)</td>
<td>(0.09)</td>
<td>(0.19)</td>
<td>(0.06)</td>
<td>(0.09)</td>
<td>(0.10)</td>
</tr>
<tr>
<td>Adj. ( R^2 )</td>
<td>0.04</td>
<td>0.02</td>
<td>0.04</td>
<td>0.11</td>
<td>0.15</td>
<td>0.00</td>
</tr>
<tr>
<td>Obs.</td>
<td>266</td>
<td>217</td>
<td>90</td>
<td>142</td>
<td>90</td>
<td>74</td>
</tr>
</tbody>
</table>

Notes: The impact of \( \Delta Z \) on \( \Delta I \) is calculated as \( \frac{\delta_1+\delta_2}{1-\gamma_1-\gamma_2} \). The impact of \( \Delta I \) on \( \Delta Z \) is calculated as \( \frac{\beta_1+\beta_2}{1-\alpha_1-\alpha_2} \). Both variables taken in natural logarithms; standard errors in parentheses; \(*p<0.10, **p<0.05, ***p<0.01; US* = US data dropping the first part of the sample (1947-1959).\)

Of course, Granger causality does not necessarily entail true causality. More specifically, the fact that changes in autonomous demand tend to lead changes in the investment share does not necessarily imply that \( Z \) causes \( I/Y \). A plausible alternative explanation would be that changes in \( Z \) and \( I/Y \) are both caused by changes in income, but \( Z \) reacts faster than \( I/Y \). We can call this the ‘income-first’ hypothesis.

Note that it would be incorrect to test the ‘income first’ hypothesis against the ‘supermultiplier’ hypothesis, just by adding income growth as a control variable in equa-
4.7. Autonomous demand and the investment share

Figure 4.10: Relation between the investment share and lagged autonomous demand
(a)-(e): quarterly % changes; (f): 10-year average yearly growth rates

Sections 4.20 and 4.21. As explained in Section 4.2, supermultiplier theory predicts that changes in Z cause changes in GDP, which in turn cause changes in the investment share. Hence, both the alternative explanation and supermultiplier theory imply that Granger-causality between autonomous demand and the investment share would disap-
What differentiates supermultiplier theory from what we have called the ‘income first hypothesis’ is that changes in GDP, induced by changes in $Z$, are able to trigger an accelerator effect strong enough to make $I$ increase faster than $Y$. A natural way to test this is to use instrumental variables, to identify exogenous shocks in autonomous demand and check whether these shocks are accompanied by changes in the investment share. We have already identified instrumental variables for $Z$ in Section 4.6 and checked the relevance of the first-stage. Given that our instruments are available only at yearly frequencies – which substantially reduces the number of observations, but in our case also enlarges the time-period analyzed for the European countries – we employ IV panel estimators to estimate the following equation:

$$I_{c,t} = \mu_c + \sum_{i=1}^{m} \alpha_i I_{c,t-i} + \sum_{j=0}^{n} \beta_j \Delta Z_{c,t-j} + \epsilon_{c,t}$$  \hspace{1cm} (4.22)

where $I$ is the investment share\textsuperscript{40} and $Z$ is the natural log of autonomous demand. Again, we set $m = n = 2$, as suggested by both AIC and BIC information criteria. As in the previous section, a fixed-effect estimator is our preferred choice, but we estimate also pooled 2SLS, difference-GMM and system-GMM to check the robustness of results.

Estimated coefficients for $\beta_0$ and $\alpha_1$ are positive and significant, while $\alpha_2$ is negative and significant; $\beta_1$ and $\beta_2$ are not significantly different from zero – as expected given that we are using yearly data and that Granger-causality tests, performed in the previous section, found the effect of $Z$ on $I/Y$ to last around two quarters. Results imply that, in the long-run, an additional 1% increase in autonomous demand raises the investment share by 0.57 percentage points of GDP.\textsuperscript{41} The impulse response function is depicted in Figure 4.11, over a time-horizon of 4 years.

Results are robust to the use of different estimators instead of fixed-effects. The estimated long-run effect of $Z$ growth on $I/Y$ is 1.13% of GDP with pooled TSLS, 0.28% with difference-GMM and 0.87% with system-GMM. In all cases, the positive effect of $Z$ growth on $I/Y$ is statistically significant at the 0.05 confidence level.

\textsuperscript{40}While in equations 4.20 and 4.21 $I_t$ represents the natural log of the investment share, in 4.22 it represents the investment share ($I/Y \cdot 100$).

\textsuperscript{41}We calculate the long-run effect of $Z$ on $I/Y$ as $\frac{\beta_0 + \beta_1 + \beta_2}{1 - \alpha_1 - \alpha_2}$. 

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4.8 Concluding Remarks

As we have tried to synthetically convey in Section 4.2.1, the Sraffian supermultiplier model represents an interesting, recent attempt to develop and formalize a realistic, if schematic and necessarily partial, approach to economic growth. As Serrano puts it, the model is a contribution

“to a line of research started by Garegnani (1962) concerning the development of an alternative long-period theory of output and accumulation characterized by two main features: (i) the validity of the Keynesian-Kaleckian principle of effective demand in the long-run, that is, in situations which take explicitly account of the capacity generating effects of investment expenditures; (ii) the full compatibility of the analysis with the Classical Surplus approach to the theory of value and distribution, revived by Sraffa (1960).” (Serrano, 1995, p. 1)

In this chapter, we have attempted a first empirical test of the model. We have calculated time-series of the autonomous components of aggregate demand and of the supermultiplier for the US, France, Germany, Italy and Spain and described their patterns in recent decades: the whole after-WWII period for the US; 1970-2013 for France; 1980-2013 for Italy and Spain; 1991-2013 for Germany. We have then performed econo-

Figure 4.11: Estimated effect of an additional 1% increase in Z on the investment share (% of GDP; 2SLS fixed-effects model, yearly data, all five countries)
Our qualitative analysis has highlighted that growth rates of autonomous demand and output are tightly correlated, both in the short and in the long-run. Furthermore, the supermultiplier has been much higher in the US than in the other countries, in the whole observable period. In the four European countries, a rise in the import share, probably fueled by the process of European integration, has caused a continuous decline in the supermultiplier in our sample period. To the contrary, the supermultiplier has been broadly stable in the US since the Sixties, as a result of a decreasing propensity to save, which has compensated an increasing propensity to import.

For this reason, the US represent a suitable scenario for a cointegration analysis, in order to study the long and short-run relations between autonomous demand and output, in the presence of a generally stable supermultiplier. In this case, standard cointegration tests indicate that Z and GDP have shared a common long-run trend during the period under analysis. However, the cointegrating relation between Z and output appears to have been very unstable in the early post-WWII period. This instability seems to be ascribable to sharp changes in the propensity to save, which may be linked, at least partly, to the legacies of the wartime economy. In the 1960-2013 period, the relation seems more stable, and we have focused on that period in our analysis of causal effects.

From the estimation of a Vector Error-Correction model (VECM), we have found evidence of both short and long-run simultaneous causality between autonomous demand and output. The two variables appear to simultaneously determine each other. However, when we have tried excluding consumer credit from Z, we have found long-run causality going univocally from autonomous demand to output; short-run simultaneous causality, instead, remains. We have argued that this mutual influence between Z and GDP is not incompatible with the theory and we have proposed an explanation based on the idea that autonomous demand is socially and historically determined (an idea that proponents of the theory would not disagree with, we think).

We have not found cointegration between output and autonomous demand in the four European countries under analysis. As we have showed formally, this can be explained by the theory, given the strongly decreasing trend of the supermultiplier these countries have experimented.

To tackle endogeneity problems, we performed a 2SLS panel estimation of the short-run effect of Z on output, employing annual data. In our baseline fixed-effects specification, we have found an impact-multiplier of 1.3 and a 4-years cumulative multiplier of 1.6. As instruments for Z, we utilized military spending, US growth (for the European countries) and an index of trade restrictions imposed by Canada and Mexico (for the
4.8. Concluding Remarks

A further implication of the model that we tested against empirical evidence is that accelerations in autonomous demand growth tend to be followed by increases in the investment share. Through Granger-causality tests and Instrumental Variables regressions, we have found that this is the case in all five countries. On average, an additional percentage increase in autonomous demand growth raises the investment share by 0.57 percentage points of GDP in the long-run.

We invite to take our results with caution – this is just a first tentative approach to testing Serrano’s model empirically; it will be necessary to include other countries in the assessment and to try more ingenious ways to deal with endogeneity, when testing for causality. Nevertheless, it seems fair to state that the evidence provided in this paper is rather favorable to the Sraffian supermultiplier model – consistently with the findings presented by Médici (2011) on Argentina’s economy. At the same time, our results suggest that the role of consumer credit in the model may need some rethinking. This component would appear not to be autonomous in the short nor in the long-run.

Empirical tests in macroeconomics are admittedly imperfect and controversial; variables are imprecisely measured, endogeneity is pervasive and the treatment is all but randomly assigned. At the same time, we are convinced that it is essential to assess whether there is evidence in the data of the kind of relations between economic variables that the theory predicts. We thus hope that the exercises performed in this paper can give a useful contribution – for how preliminary, imperfect and limited in scope – to the line of research indicated by Garegnani and continued by Serrano and other authors.
Appendix

4.A Dataset and sources

The dataset employed, from which all results can be reproduced, is available at this link: http://goo.gl/IixDBB. Hereafter is the list of all sources.

4.A.1 US data

**GDP**  - US Bureau of Economic Analysis, Real Gross Domestic Product, 3 Decimal [GDPC96], retrieved from FRED, Federal Reserve Bank of St. Louis https://research.stlouisfed.org/fred2/series/GDPC96/; US Bureau of Economic Analysis, Gross Domestic Product [GDP], retrieved from FRED, Federal Reserve Bank of St. Louis https://research.stlouisfed.org/fred2/series/GDP (The first measure – real GDP – is used as a proxy for output, while the second – nominal GDP – is used as the denominator in the import share)

**Exports**  US Bureau of Economic Analysis, Real Exports of Goods & Services, 3 Decimal [EXPGSC96], retrieved from FRED, Federal Reserve Bank of St. Louis https://research.stlouisfed.org/fred2/series/EXPGSC96/


**Housing Investment**  - US Bureau of Economic Analysis, Shares of gross domestic product: Gross private domestic investment: Fixed investment: Residential [A011RE1Q156NBEA], retrieved from FRED, Federal Reserve Bank of St. Louis https://research.stlouisfed.org/fred2/series/A011RE1Q156NBEA/
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**Consumer credit** - Board of Governors of the Federal Reserve System (US), Total Consumer Credit Owned and Securitized, Outstanding [TOTALSL], retrieved from FRED, Federal Reserve Bank of St. Louis https://research.stlouisfed.org/fred2/series/TOTALSL/ (We calculate real quarterly net flows of consumer credit as follows: we take end-of-period stocks in each quarter and transform them in first differences to obtain net flows. Then we deflate the resulting series using the GDP implicit price deflator).


**Households’ Consumption** - US Bureau of Economic Analysis, Real Personal Consumption Expenditures [PCECC96], retrieved from FRED, Federal Reserve Bank of St. Louis https://research.stlouisfed.org/fred2/series/PCECC96/


**Military spending**  SIPRI military expenditure database http://www.sipri.org/research/armaments/milex/milex_database


4.A.2 Data on Western European countries

4.A. Dataset and sources


IFPRI Public Expenditure Database, Percentage of total Public Expenditure in Total GDP, retrieved from International Food Policy Research Institute http://www.ifpri.org/publication/public-expenditure-database


Consumer credit - OECD, OECD.StatExtracts, Finance, Households’ financial and non-financial assets and liabilities, Consumer credit - up to 1 year and Consumer credit - more than 1 year, retrieved from OECD http://stats.oecd.org/Index.aspx?DataSetCode=TIS


Business investment We define business investment as: Gross Fixed Capital Formation minus General Government Gross Fixed Capital Formation minus Residential
Investment.\textsuperscript{42}


IFPRI Public Expenditure Database, Percentage of Total Public Expenditure in Total GDP, retrieved from International Food Policy Research Institute

http://www.ifpri.org/publication/public-expenditure-database

OECD, National Accounts at a glance 2014, Gross Fixed Capital Formation, General Government, Percentage of Total GFCF, retrieved from OECD


OECD, Gross Domestic Product, SNA 1993, Gross Fixed Capital Formation: Housing, retrieved from OECD


\textbf{Households’ Consumption} – Eurostat Quarterly National Accounts (ESA95), Households and NPISH final consumption expenditure, retrieved from Eurostat


Eurostat Annual National Accounts (ESA95), Households and NPISH final consumption expenditure, retrieved from Eurostat


\textsuperscript{42}In this way, we subtract twice, from total Gross Fixed Capital Formation, General Government housing investment. In the absence of comprehensive time-series on this variable, we use our definition as a reasonable approximation of business investment, on the basis of the assumption that the share of public housing investment is very small relative to total investment.
4.A. Dataset and sources

Imports – Eurostat Quarterly National Accounts (ESA95), Imports of goods and services, retrieved from Eurostat
Eurostat Annual National Accounts (ESA95), Imports of goods and services, retrieved from Eurostat


4.A.3 Notes on the dataset construction

Series in nominal terms were deflated by applying the appropriate deflator. Military spending was calculated by taking the time-series of military spending as a % of GDP from the SIPRI database, and then multiplying that share for the Eurostat real GDP series.

In the case of France’s yearly data, the Eurostat National Account series for Gross Fixed Capital Formation: Dwellings and for General Government Gross Fixed Capital Formation, which start in 1978, have been chained backwards using, respectively, the growth rate of Gross Fixed Capital Formation: Housing and of General Government Gross Fixed Capital Formation, from OECD Stats.

In the case of Italy’s yearly data, Eurostat National Account series, which start in 1990, have been chained backwards using growth rates of corresponding variables from OECD Stats.

In the case of Spain’s yearly data, the Eurostat National Account series for General Government Gross Fixed Capital Formation starts in 1995. For this reason, we have chained, backward from this year, the series for Government Expenditure (General Government final consumption plus General Government Gross Fixed Capital Formation), constructed upon Eurostat data. We have used, for this purpose, the growth rate of Total Public Expenditure from the IFPRI Public Expenditure Database. After doing that, we subtracted from our new series of Government Expenditure the values of General Government final consumption and we obtained the series of General Government Gross Fixed Capital Formation for the 1980-1995 period.

All the backwards interpolations were performed after having verified that the rates of growth of the relative magnitudes, derived from different sources, were highly correlated in the periods covered by both sources.
4.B  The relative weight of consumer credit flows

As explained in Section 4.3, consumer credit was excluded from the calculation of autonomous demand (Z) for three out of four European countries in our sample, due to the unavailability of comprehensive time-series. We have seen that in the US, for which it was included in the computation of Z, consumer credit (which excludes loans for house purchases) accounts for an exiguous share of Z (Figure 4.3). In this appendix we show, on the basis of the available information, that the same applies to Spain, where consumer credit was included in the quarterly series but not in the yearly series, and to France and Italy. (Data on consumer credit in Germany are not available; however it appears safe to assume that flows of consumer loans in Germany have not been higher, in relative terms, than in the other three European countries.)

Let us examine the yearly series made available by the OECD, which start in the late Nineties (1996 for France, 1998 for Spain and 1999 for Italy).\footnote{We include Spain in the figure for the sake of comparison, even if for this country the consumer credit component has been comprised in the empirical analysis.} On average over that period, the absolute value of the yearly net flow of consumer credit\footnote{In particular, to calculate the net flow of new consumer credit, we have taken first differences of the end-of-year stock of consumer credit (i.e., the sum of ‘consumer credit, up to one year’ plus ‘consumer credit, more than one year’ in the OECD database). The net flow of new consumer credit can thus be negative, as happens in years in which the stock of debt diminishes (meaning that the amount of money used by families to repay past debts has surpassed the amount of new consumer credit conceded).} (CC) accounts for 0.7% of GDP in Italy and France and 1.2% of GDP in Spain. As a share of Z, again taking absolute values, CC averaged 1.2% in France, 1.3% in Italy and 1.8% in Spain.

House mortgage loans (that we included in our calculation of Z, using housing investment as a proxy) appear more relevant. On average over the available series, net flows of loans for house purchases amounted (in absolute value) to 6.2% of GDP and 9.9% of Z in Spain; 3.6% of GDP and 5.5% of Z in Germany; 3.0% of GDP and 4.8% of Z in France; 2.1% of GDP and 3.9% of Z in Italy. If we calculate overall households autonomous spending as the sum of the net flows of consumer loans and loans for house purchases, we see that house mortgages accounted for 70% of the total in France, 73% in Italy and 82% in Spain.

In conclusion, while consumers’ debt as a stock may have reached considerable levels, possibly relevant for financial stability, the yearly net flows of consumer credit – which are what matters for our analysis of the impact of autonomous spending on GDP growth – have been very small with respect to overall autonomous demand. To the contrary, borrowing for house purchases (which we included in our Z estimates, using residential investment as a proxy) financed the vast majority of households’ autonomous spending.
4.B. The relative weight of consumer credit flows

Figure 4.12: Net flows of consumer credit
(yearly change in the stock of consumer loans outstanding.)
Source: Authors own elaboration on OECD and Eurostat data

Figure 4.13: Net flows of loans for home purchases
(yearly change in the stock of loans for home purchases outstanding.)
Source: Authors own elaboration on OECD and Eurostat data
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