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Autonomous demand and the investment share*

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This paper looks at the effect of demand shocks on the investment share of the economy. Using panel data on 20 OECD countries, we show that the rate of growth of autonomous demand (exports, public spending, and housing investment) is positively correlated with subsequent values of the share of business investment in GDP. By means of an instrumental-variables (IV) strategy, we confirm a positive effect of demand dynamics on the business investment share. We instrument autonomous demand with (i) US demand for imports interacted with exposure to trade with the US, (ii) openness to trade of a country's main export destinations, and (iii) military spending. A permanent 1-percentage-point increase in autonomous-demand growth raises the investment share by 1.5 to 1.9 percentage points of GDP in our preferred panel IV specification. Our results provide empirical support for the view that the influence of aggregate demand on capital accumulation can be a major source of hysteresis. Our results are inconsistent with the canonical New Keynesian three-equations model, the Neo-Kaleckian model with flexible equilibrium utilization, and Classical–Marxian growth models. A positive influence of autonomous demand on the investment share is instead compatible with demand-led models in which capacity adjusts to demand in the long run.

Keywords: *hysteresis, investment, demand-led growth, capacity adjustment, supermultiplier*

JEL codes: *C26, E11, E12, E22, O41*

1 INTRODUCTION AND MOTIVATION

What determines the share of national product that is devoted to private productive investment? Does it depend solely on structural supply-side factors and preferences ('thriftiness'), as implied by Neoclassical macroeconomics? Or can it be influenced by aggregate demand trends, fiscal policy, and export dynamics? The question is

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highly relevant, given that the investment share is positively associated with long-run economic potential both theoretically and empirically. It also relates to the ongoing debate on hysteresis:[1] recent contributions have pointed to the impact of demand on capital accumulation as a major potential source of hysteresis (for example, Ball 2014; Reifschneider et al. 2015; Fatás and Summers 2016). Indeed, a positive effect of aggregate demand dynamics on the investment share would not be compatible with theoretical models in which potential output is independent of aggregate demand.

This paper tackles this question empirically: we estimate the effect of autonomous demand on the share of business investment in GDP.

Our empirical analysis uses a quarterly and a yearly panel of 20 advanced economies for the 1960–2016 period. We define autonomous demand as the sum of exports, public spending, and housing investment. This definition reflects a simple Keynesian model, in which consumption and business investment are induced (determined by current and expected income), while exports and government spending are the components of aggregate demand that can potentially move independently of income. We include also housing investment in our definition of autonomous demand, because it is partly determined by demographic and financial factors. Note that our definition of autonomous demand does not imply statistical exogeneity: exports, public spending, and housing expenditure are certainly influenced by domestic macroeconomic conditions. In fact, we take endogeneity issues seriously, and propose an instrumental-variable approach to isolate exogenous variation in autonomous demand.

First, we use dynamic-panel models to show that changes in autonomous demand growth tend to be followed by changes of the same sign in the business investment share of GDP. This result is robust to controlling for lags of the investment share, two-way fixed effects, the interest rate, and the profit share. We find, however, evidence of endogeneity of some autonomous components of demand.

We tackle endogeneity by proposing a panel instrumental-variables approach to estimate the effect of autonomous demand. We propose three external instruments for autonomous demand in a country *i*:

- US aggregate demand for imports (excluding imports from country *i*) weighted by *i*'s exposure to trade with the US;
- weighted-average openness to trade of the five main export destinations of country *i*; and
- military expenditure.

Our preferred estimates use only variation in autonomous demand that is driven by these three instrumental variables. We also show that our results are robust to using semi-parametric local projections (Jordà 2005) instead of dynamic-panel models. According to our preferred IV specifications, a 1-percentage-point permanent increase in autonomous-demand growth increases the business investment share by 1.5 to 1.9 percentage points of GDP in the long run.

We then assess the compatibility of our findings with alternative macroeconomic models. Pointing to an effect of aggregate demand on the evolution of productive capacity, our results are at odds with models in which potential output is fully determined by supply-side factors. For example, in the canonical Neo-Keynesian three-equations model, increases in autonomous demand are associated with a reduction of the equilibrium

1. By 'hysteresis' we mean the idea that 'changes in aggregate demand may have an appreciable, persistent effect on aggregate supply – that is, on potential output' (Yellen 2016, p. 2).

investment share. The same can be said of models in the Classical–Marxian tradition (Duménil and Lévy 1999), in which long-run outcomes are also supply-determined.

Demand-led growth models are natural candidates to explain our findings. However, this is not true for all such models. Neo-Kaleckian models that rely on flexible equilibrium capacity utilization (Amadeo 1986; Hein at al. 2012) in fact are not able to explain our results. The positive influence of autonomous demand on the investment share is instead compatible with autonomous-demand-led growth models in which capacity adjusts to demand in the long run. In Appendix 3 (available online at https://doi.org/10.4337/roke.2020.03.10), we provide a formal stylized model of this class, drawing on the 'supermultiplier' literature (Freitas and Serrano 2015), showing that in this framework a higher growth rate of autonomous demand implies a higher investment share.

Besides contributing to a large literature on the determinants of business investment,[2] our findings are informative for the debate on hysteresis and for models of demand-led growth. To the best of our knowledge, this is the first paper to estimate the impact of autonomous-demand shocks on the share of business investment in GDP.[3] Moreover, we introduce novel instrumental variables for exports, which we think could be used fruitfully in future research on the impact of autonomous demand and exports on various outcome variables.

2 IDENTIFICATION ISSUES AND RESEARCH DESIGN

Estimating the causal effect of autonomous-demand growth on the business investment share is challenging, owing to the presence of various potential confounders. Changes in the autonomous components of demand are partly endogenous to macroeconomic conditions that also affect business investment and GDP (the numerator and the denominator of our outcome of interest).[4] Each autonomous component of demand – public spending, exports, and housing investment – is indeed likely to react to fluctuations in aggregate business investment and GDP.

We can identify two broad potential sources of endogeneity for our analysis. First, changes in business investment may affect autonomous demand directly and through their effects on GDP growth, generating reverse-causality bias. Second, unobserved shocks to economic activity (due for example to supply-side factors or global macroeconomic factors) could drive both changes in business investment and in the autonomous components of demand, creating a problem of omitted-variable bias.

Our identification strategy is based on the use of panel-data techniques and instrumental variables. First, we estimate a dynamic-panel model on quarterly data, controlling for a

2. See for example the surveys of Chirinko (1993) and Caballero (1999).
3. A related exercise is performed in Blomström et al. (1996), which investigates the causal relationship between (per capita) GDP growth and the fixed investment share in GDP, concluding that 'growth induces subsequent capital formation more than capital formation induces subsequent growth' (ibid., pp. 275–276). In Girardi and Pariboni (2016) we present some preliminary results on the relationship between autonomous demand and the investment share, within a more general empirical analysis on the role of autonomous demand as a driver of growth in the US.
4. Girardi and Pariboni (2015, p. 27; 2016, pp. 13–14) find that autonomous demand does not appear fully exogenous using US time-series data and discuss at length the potential sources of endogeneity affecting each autonomous component of demand.

full set of country and time-fixed effects, to assess whether changes in autonomous demand tend to predict ('Granger-cause') subsequent changes in the business investment share, and/or vice versa. This first analysis is useful in exploring possible lead–lag relations between the two variables. It effectively controls for country-specific time-invariant factors and time-varying common shocks, while accounting for persistence in the outcome variable. We also control for the real interest rate and the profit share. However, our panel Granger-causality analysis may still suffer from endogeneity bias related to country-specific time-varying unobserved factors influencing both the treatment and the outcome.

We address these concerns through an instrumental-variables approach. We propose three external instruments for autonomous demand in a country *i*: US aggregate demand for imports (excluding imports from country *i*) interacted with country *i*'s exposure to trade with the US; weighted-average openness to trade of the five main export destinations of country *i*; and military expenditure. We define and discuss in detail each of these instruments in Section 5. We argue that using only changes in autonomous demand that are driven by these three factors is likely to largely remove endogeneity bias, producing credible estimates of the causal effect of autonomous demand.

To make sure that our estimates of the effect of autonomous demand on the investment share are not driven by the parametric model imposed by our dynamic-panel specification, we also present estimates using a semi-parametric local-projections (LPs) specification (Jordà 2005). LPs allow us to estimate the effect of the treatment at different time horizons, without assuming any underlying parametric model for the dynamics of the outcome variable. Results from LP estimates confirm that changes in autonomous-demand growth have a significant and economically relevant positive effect on the business investment share.

3 DATA AND DESCRIPTIVE EVIDENCE

3.1 Data

We build both a quarterly and a yearly panel including 20 OECD countries for the 1960–2016 period.[5] The yearly panel will be used in the instrumental-variables estimations, given that the external instruments we will use are not available at a quarterly frequency. Because of data availability, the yearly IV estimations will focus on the 1970–2015 period. Our outcome of interest is the ratio of private non-residential investment to GDP (hereafter, business investment share, or simply investment share). The main regressor of interest is the rate of growth of autonomous demand. We define autonomous demand as the sum of exports, general government final consumption, general government gross fixed capital formation, and housing investment. Our data set also includes, as control variables, the real interest rate and the profit share. The former is the rate of interest on long-term government bonds, corrected

5. The countries are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Korea, the Netherlands, New Zealand, Norway, Spain, Sweden, the United Kingdom, and the United States. Our sample includes all the countries for which yearly and quarterly business investment data are available (from the OECD Economic Outlook No 101 or from previous editions).

Table 1 Descriptive statistics

(a) Quarterly data (1960Q1–2016Q4)					
	n	Mean	s.d.	Min.	Max.
Business investment share (% of GDP)	3427	12.0	3.8	2.6	30.1
Autonomous demand (% change)	3427	0.9	1.8	−10.4	13.7
Real interest rate (%)	3222	5.7	3.5	−20.5	30.3
Profit share (%)	1901	32.2	4.1	21.2	49.0
(b) Yearly data (1970–2015)					
	n	Mean	s.d.	Min.	Max.
Business investment share (% of GDP)	1022	11.7	3.9	1.3	29.6
Autonomous demand (% change)	1022	3.7	3.6	−23.8	21.5
Military spending (% change)	972	1.5	5.8	−23.3	34.3
Openness of export destinations (index)	866	4.3	0.2	3.7	4.6
Openness of export destinations (% change)	852	0.1	0.6	−2.5	2.4
Jack-knifed US imports growth × exposure	979	0.9	2.0	−13.4	17.8
Real interest rate (%)	986	2.6	3.4	−17.8	23.0
Profit share (%)	758	30.9	5.8	4.0	46.6

Note: See Appendix 1 (available online at https://doi.org/10.4337/roke.2020.03.10) for a description of the data set construction and sources.

for inflation. The latter is the share of gross operating surplus and mixed income, adjusted for the imputed compensation of self-employed, in GDP.

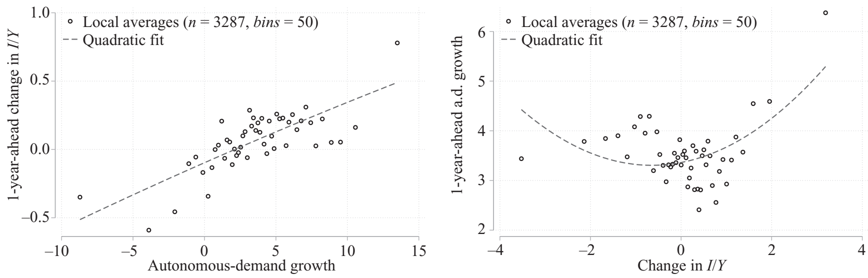
Descriptive statistics are reported in Table 1. All variables are taken in real terms. Quarterly series are all seasonally adjusted. See Appendix 1 (available online at https://doi.org/10.4337/roke.2020.03.10) for details on the definitions and sources of all variables.[6]

3.2 Descriptive evidence

We start by providing descriptive visual evidence on our relation of interest, using the quarterly panel data set. The left panel of Figure 1 plots the year-on-year growth rate of autonomous demand (on the horizontal axis) versus the subsequent one-year-ahead change in the business investment share.[7] Given the large number of observations ($n = 3287$), we plot local averages instead of single observations for ease of visualization.[8] This means that each point in the graph represents the average of all observations around that point (this will apply also to Figures 2–4). We fit a quadratic regression line to accommodate possible non-linearities.

Figure 1a clearly suggests that a higher growth rate of autonomous demand tends to be correlated with a higher subsequent change in the business investment share. The relation seems broadly linear.

6. As described in detail in Appendix 1, our main source is the OECD Economic Outlook No 101, but we also use other auxiliary sources for some variables that are not available in the OECD EO.
7. The year-on-year growth rate is the percentage change over the same quarter in the previous year. The one-year-ahead change is the percentage change between t and $t + 4$.
8. We use the binscatter package in STATA to compute and plot local averages.



(a) Autonomous-demand growth vs one-year-ahead change in I/Y (b) Change in I/Y vs one-year-ahead autonomous-demand growth

Figure 1 Relation between autonomous demand and the business investment share (quarterly panel, 1960–2016)

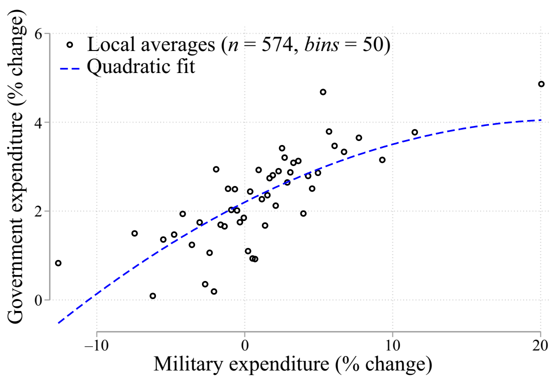


Figure 2 Military expenditure vs total government expenditure (yearly panel, 1970–2015)

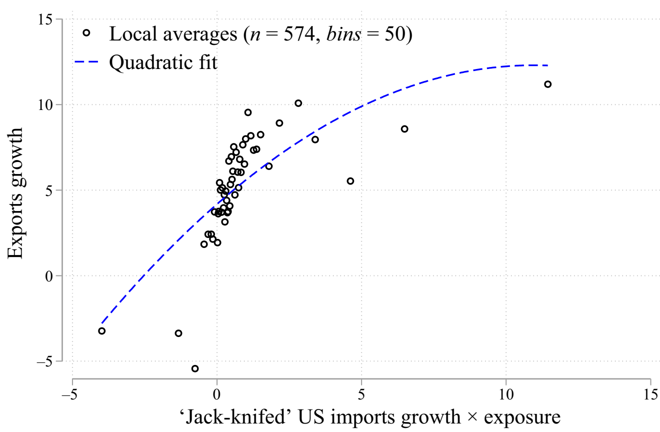


Figure 3 'Jack-knifed' US import growth × exposure vs exports (yearly panel, 1970–2015)

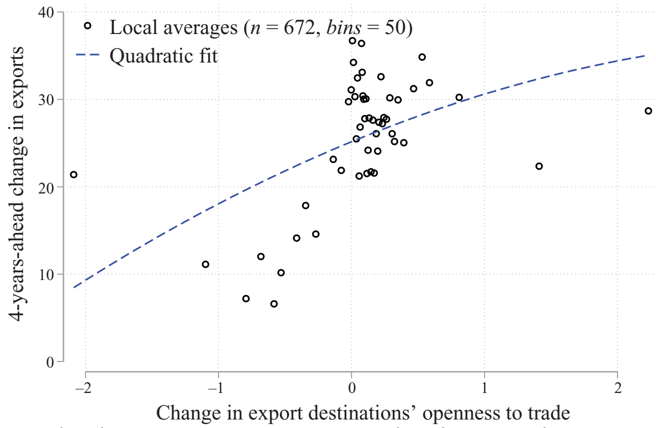


Figure 4 Weighted-average openness to trade of export destinations vs exports (yearly panel, 1970–2015)

Figure 1b investigates whether changes in the investment share are correlated with subsequent values of autonomous-demand growth. An association between changes in the investment share and subsequent autonomous-demand growth would suggest the possible presence of reverse-causality. The association, however, seems to be quite weak. The quadratic regression line seems to point to a U-shaped relation, with no clear positive or negative association between the two variables. In other words, larger changes in the investment share do not seem to predict higher subsequent autonomous-demand growth.

The simple descriptive evidence provided by Figure 1 is clearly consistent with a positive impact of autonomous-demand growth on the investment share. However, while this simple exercise does not suggest pervasive reverse-causality, obviously it does not prove its absence, and – most importantly – it does not rule out other sources of endogeneity.

The aim of the next two sections is to assess whether the positive relation between autonomous demand and the investment share depicted in Figure 1a is spurious or reflects a genuine causal effect.

4 DYNAMIC-PANEL GRANGER-CAUSALITY TESTS

To investigate more formally whether changes in autonomous demand tend to be followed by same-sign changes in the business investment share (as suggested by Figure 1), we perform Granger-causality tests, using a dynamic-panel specification on our quarterly data set.

The regressions we estimate in this section have the following generic form:

$$I/Y_{i,t} = \alpha_i + \delta_t + \sum_{j=1}^{p} \beta_j \Delta z_{i,t-j} + \sum_{j=1}^{p} \gamma_j \Delta(I/Y)_{i,t-j} + \varepsilon_{i,t}, \qquad (1)$$

where $I/Y_{i,t}$ is business investment as a percentage of GDP in country i at time t, and z is the natural log of autonomous demand. α_i are country fixed effects, and δ_t are

Table 2 Panel unit-root tests (test statistics for the null hypothesis of a unit root; quarterly data)

	IPS test	LLC test
Investment share	−3.38	−2.60
	(p = 0.0004)	(p = 0.0047)
Autonomous-demand growth	−45.36	−26.67
	(p < 0.0000)	(p < 0.0000)

Notes: IPS = Im et al. (2003); LLC = Levin et al. (2002). No of lags selected by AIC criterion. LLC test requires a balanced panel, so in performing it we restrict the time dimension of the sample to the period for which we have quarterly data for all countries (2002Q1–2014Q4).

(year-quarter) time effects.[9] Testing for Granger causality implies testing the joint hypothesis that $\beta_j = 0$ for all j (Granger 1980).[10]

This specification assumes that I/Y and Δz are stationary variables. This assumption is supported by the panel unit-root tests reported in Table 2. Both the Im et al. (2003) and the Levin et al. (2002) tests comfortably reject the null of non-stationarity for both variables.

4.1 Baseline results from dynamic-panel models

Table 3 displays results from the estimation of various versions of equation (1). Columns 1 and 2 present results from a pooled ordinary least squares (OLS) estimator (which assumes $\alpha_i = \delta_t = 0$); columns 3 and 4 a within-countries model (which allows for country fixed effects but not time fixed effects); and columns 5 and 6 a two-way fixed effects model that includes a full set of country and time (year-quarter) dummies. Our preferred specifications include four lags (columns 1, 3, and 5), since we find all subsequent lags to be near zero and statistically insignificant. However, for each model, we report results also using eight lags (columns 2, 4, and 6) for robustness. To account for serial correlation both within countries and within time periods, we report two-way clustered standard errors (Cameron et al. 2011).

Results confirm the indications of Figure 1: lagged values of autonomous-demand growth have a positive and significant effect on the business investment share in all specifications. The null-hypothesis that autonomous-demand growth does not Granger-cause the investment share is rejected at the 1-percent significance level in all specifications.

9. As is well known, the inclusion of both country fixed effects and autoregressive dynamics may generate the so-called 'Nickell bias' (Nickell 1981). This bias is however of order $1/T$ and should thus be completely negligible in our large-T panel (we have an average of 171 quarterly observations for each country, with a minimum of 51 and a maximum of 227). Indeed, Judson and Owen (1999) provide evidence from Monte Carlo simulations, suggesting that when estimating dynamic-panel models on macroeconomic data sets, the fixed-effects model is superior to the alternatives as long as $T \geq 30$. Nickell bias may be an issue in our yearly data set, where we have a smaller T, and therefore we will present results both including and excluding country fixed effects.

10. 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 $E(y_t|y_{t-1}, y_{t-2}, \ldots, x_{t-1}, x_{t-2}, \ldots) \neq E(y_t|y_{t-1}, y_{t-2}, \ldots)$.

Table 3 Panel Granger-causality test between autonomous-demand growth (ΔZ) and the business investment share (I/Y) (quarterly data, 1960Q1–2016Q4)

	Dependent variable: business investment share (*I/Y*)					
	Pooled OLS		Within-countries		Two-way FE	
	(1)	(2)	(3)	(4)	(5)	(6)
ΔZ_{t-1}	0.008	0.009	0.004	0.006	−0.002	−0.002
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.012)
ΔZ_{t-2}	0.028***	0.030***	0.025***	0.027**	0.017*	0.019*
	(0.009)	(0.010)	(0.008)	(0.010)	(0.009)	(0.010)
ΔZ_{t-3}	0.032***	0.034***	0.029***	0.031***	0.028***	0.031***
	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)	(0.007)
ΔZ_{t-4}	0.020**	0.020*	0.018**	0.017*	0.020*	0.019*
	(0.010)	(0.010)	(0.009)	(0.008)	(0.011)	(0.011)
ΔZ_{t-5}	–	−0.001	–	−0.003	–	−0.001
	–	(0.005)	–	(0.004)	–	(0.007)
ΔZ_{t-6}	–	0.009	–	0.006	–	0.014
	–	(0.007)	–	(0.007)	–	(0.008)
ΔZ_{t-7}	–	−0.008	–	−0.010	–	0.002
	–	(0.009)	–	(0.010)	–	(0.011)
ΔZ_{t-8}	–	−0.007	–	−0.009	–	−0.002
	–	(0.006)	–	(0.006)	–	(0.007)
F-stat G.-causality	12.61	18.58	12.09	18.97	5.32	4.14
p-value F-stat.	3.56e-05	1.89e-07	4.70e-05	1.59e-07	0.005	0.005
Long-run effect of ΔZ	5.212	5.278	2.202	1.880	1.415	1.795
	(1.338)	(1.371)	(0.561)	(0.601)	(0.479)	(0.582)
Persistence of *I/Y*	0.983	0.984	0.965	0.965	0.955	0.955
	(0.003)	(0.004)	(0.008)	(0.008)	(0.006)	(0.007)
Country FE	–	–	Yes	Yes	Yes	Yes
Year-quarter FE	–	–	–	–	Yes	Yes
Observations	3347	3267	3347	3267	3347	3267
Countries	20	20	20	20	20	20

Notes: Robust standard errors clustered by country and year-quarter in parentheses. All regressions include a constant term and lags of the dependent variable. Z is the natural log of autonomous demand. *I/Y* is the ratio of business investment to GDP. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

We calculate the long-run effect of autonomous demand implied by our dynamic-panel model according to the formula $(\sum_{j=1}^{p}\beta_j)/(1-\sum_{j=1}^{p}\gamma_j)$. In our context, the long-run effect can be interpreted as the change in the equilibrium value of the business investment share caused by a permanent 1-percentage-point increase in the growth rate of autonomous demand. We find a long-run effect between 1.4 and 2.2 percentage points of GDP in the specifications controlling for fixed effects.

In Table A1 (available online at https://doi.org/10.4337/roke.2020.03.10) we use the same dynamic-panel models to assess whether past values of the business investment share help predict autonomous-demand growth – that is, whether the investment share Granger-causes autonomous demand. While the pooled model (that does not control for fixed effects) confirms the visual evidence of Figure 1b of a weak non-significant relation (column 1), in this case the inclusion of fixed effects changes the picture. The fixed-effects estimates are indeed indicative of some predictive power of the investment share over future values of autonomous-demand growth: the null hypothesis of no Granger causality is rejected at a 5-percent significance level in all specifications including fixed effects (columns 3 to 6).

4.2 Robustness of the dynamic-panel analysis

In Table A3 (available online at https://doi.org/10.4337/roke.2020.03.10) we test the robustness of our results to the inclusion of control variables, namely the real interest rate and the profit share. We estimate an augmented version of equation (1), which includes contemporaneous and lagged values of the real interest rate and the profit share. This exercise must be interpreted with caution: it implicitly assumes that the real interest rate and the profit share are exogenously determined. In fact, both variables are in all likelihood correlated with the error term through the central bank's reaction function, the negative impact of the unemployment rate on real wages, and the potential effects of changes in investment on the share of capital.[11] The endogeneity of the two control variables is likely to bias also the coefficients of the treatment of interest (Frölich 2008, pp. 216–220), which is why we do not include these controls in our baseline Granger-causality specifications. Still, we find it useful to check whether the inclusion of these two potential determinants of business investment alters our results in any meaningful way.

As shown in Table A3 (available online at https://doi.org/10.4337/roke.2020.03.10), results are not qualitatively altered by the inclusion of these two (endogenous) controls. Coefficients on lagged values of autonomous-demand growth remain positive, although less precisely estimated in the specification with quarterly dummies, and the implied long-run effect is positive and of similar magnitude. The null of no Granger causality is rejected at least at the 10-percent significance level in all specifications. The implied long-term effects of the interest rate and the profit share are statistically significant and have the expected sign (negative for the interest rate and positive for the profit share), although they can hardly be given a causal interpretation, due to the endogeneity problems just discussed.

4.3 Disaggregated regressions

It is important to assess whether the predictive power of autonomous-demand growth on the investment share is driven by some single component of autonomous demand, or is a property of autonomous demand as an aggregate. We estimate a battery of Granger-causality tests using the dynamic-panel model described by equation (1), between each component of autonomous demand and the business investment share. For each component, we also estimate reverse Granger causality, in order to have a measure of endogeneity.

Results of these 'disaggregated' regressions are reported in Table A2 (available online at https://doi.org/10.4337/roke.2020.03.10). In the interest of facilitating comparison, the first row reports the effect of aggregate autonomous demand implied by our baseline Granger-causality specification. The estimated effects of all autonomous-demand components are positive and of similar magnitude in our preferred two-way fixed-effects specification. However, they are imprecisely estimated: only

11. See for example Tavani and Zamparelli (2017), who discuss at length the influence of government consumption on the wage share.

for housing investment are we able to reject the null of no Granger causality at conventional levels of significance. Overall, these results appear to suggest that the effect of autonomous demand on the investment share is not driven by one single component but is a property of autonomous demand as a whole.

Reverse Granger causality tests reveal an interesting pattern in the endogeneity of different components. Exports are negatively related to past values of the investment share. This is not unexpected: faster growth of the domestic economy, which usually correlates to a higher investment share, can be a drag on exports because of its effect on domestic inflation. Housing, government investment, and consumption are instead positively related to past values of the business investment share, which is consistent with previous empirical work that has found fiscal policy to be often pro-cyclical (Sorensen et al. 2001; Frenkel 2012) and housing investment to be positively related to macroeconomic conditions (Iacoviello and Pavan 2011). The null of no Granger causality, however, can be rejected only for exports and government consumption in our preferred two-way fixed-effects specification.

We interpret these 'disaggregated' results as, on the one hand, suggesting that our focus on aggregate autonomous demand is appropriate, but, on the other hand, indicating that endogeneity issues are relevant. Endogeneity should be tackled in a more explicit way in order to provide credible estimates of the effect of autonomous demand.[12]

5 INSTRUMENTAL VARIABLES ESTIMATION OF THE EFFECT OF AUTONOMOUS DEMAND

While our analysis so far controls for country-specific fixed effects, time-varying common shocks (absorbed by the time dummies), and investment share dynamics, it may still be biased by the presence of unobserved time-varying country-specific factors, affecting both autonomous-demand growth and the business investment share. Supply-side factors and/or institutional changes that simultaneously influence autonomous demand and the investment share may be confounding our analysis. In this section we employ an instrumental-variables (IV) approach to address these concerns. Our aim is to identify exogenous variation in autonomous demand, which can be used to estimate its causal effect.

5.1 Three instrumental variables for autonomous demand

We employ three instrumental variables for autonomous demand:

1. demand for imports from the largest world economy (the US) weighted by a country's exposure to trade with the US;
2. an index measuring the weighted-average openness to trade of a country's main export destinations; and
3. military spending.

12. The main potential confounding variable in our analysis is GDP growth, which may drive both autonomous demand and the investment share, resulting in omitted-variable bias. Note that it would be incorrect to deal with this issue by adding GDP growth as a control variable in equation (1). In the short run, changes in GDP depend on changes in autonomous demand, both mechanically and because of the multiplier effect. And aggregate income growth is precisely the channel through which autonomous demand is expected to influence business investment. The correct way to deal with this problem is to identify changes in autonomous demand that are exogenous to domestic macroeconomic conditions, as we attempt to do in the next section.

In what follows, we define each of these variables and motivate its use as an exogenous instrument, before presenting first-stage and 2SLS estimations.

5.1.1 Jack-knifed US import growth × exposure to the US

Changes in overall US demand for imports, driven by the internal dynamics of the US economy, are certainly a major determinant of exports for all countries in our sample. At the same time, there is large variability across countries in the degree of 'exposure' to demand shocks coming from the US. For example, an increase in US demand for foreign products will affect Canada more than Japan, and Japan more than the Netherlands. Our first instrumental variable is based on this logic.

Specifically, for each country i and year t, we calculate the growth rate of US demand for imports, excluding imports from country i. In this way, we exclude changes in US imports that may be directly related to changes in the competitiveness of country i (and therefore might be endogenous). We call this variable 'jack-knifed US imports demand.'

We then multiply this 'jack-knifed US imports demand' variable by the share of the exports of country i that are absorbed by the US. In this way, we take into account the fact that a given increase in US aggregate demand for imports will imply a much larger shock for (say) Canada than for the Netherlands. To avoid endogeneity, we calculate five-year averages of the share of exports going to the US, and in each year t we use the data for the previous five-year period, rather than for year t.

Formally, this instrument is calculated as:

$$\begin{aligned}\Delta US\,Demand_{i,t} &= j.k.US\,import\,growth \times exposure = \\ &= [\Delta ln(M_{US,t} - M_{US\to i,t}) * 100] \times \overline{(X_{i\to US}/X_i)}_{past},\end{aligned}$$

where t is time (years), M_{US} are overall US imports, $M_{US\to i} = X_{i\to US}$ are US imports from country i (or, equivalently, i's exports towards the US), X_i is the total exports of country i, and $\overline{X}_{past}$ is the five-year average of variable X in the previous five-year period (not including year t).

When controlling for year effects, identification of the effect of autonomous demand using this instrument comes entirely from cross-country variation in exposure to the US. For example, in the presence of a general rise in US demand for imports in year t, Canada will be impacted much more than the Netherlands. We therefore test whether the investment share will react more in Canada than in the Netherlands during and after year t, as a result of this differential in the intensity of the shock.

The crucial identifying assumption we are making in using this instrument is that *past* exposure to trade with the US (as measured by $\overline{(X_{i\to US}/X_i)}_{past}$) is exogenous to future changes in the investment share. We believe that this is a reasonable identifying assumption, given that (lagged) exposure to trade with the US is largely determined by geography and by the industry mix that a country has inherited from the past and which is basically fixed in the short run.[13]

13. This instrumental variable is similar in its logic to the so-called 'Bartik instruments,' which have been used extensively in labor economics. Bartik-type instruments attempt to isolate exogenous labor-market shocks at the regional level. They are built as the interaction of (lagged) regional industry shares with national industry growth rates. See Goldsmith-Pinkham et al. (2018) for a recent discussion.

The other key assumption is that US aggregate demand is not determined by macroeconomic conditions in its main trade-partner countries. This assumption may fail in a small open economy but appears reasonable for a large and relatively closed economy like the US.

Obviously, this variable is not available for the United States, therefore our IV analysis will focus on the remaining 19 countries.

5.1.2 Weighted-average openness to trade of export destinations

Our second instrumental variable is based on the idea that for a country *i*, a lifting of trade restrictions in its main export destinations can give a boost to exports, and, conversely, the erection of trade barriers in key trade partners can depress exports. For each country, we calculate the weighted-average openness to trade of its five main export destinations.

In using this instrumental variable, we are imposing the identifying assumptions that a country's trade policy is not determined by the macroeconomic conditions of its main trade partners. We see this as rather plausible.

As a measure of openness, we use the 'trade restrictions' index calculated by Dreher et al. (2008).[14] This variable is calculated on the basis of four sub-components: hidden import barriers, mean tariff rate, taxes on international trade (as a percentage of current revenue), and capital account restrictions (see Dreher 2006 and Dreher et al. 2008 for details). This variable is higher the lower the trade restrictions (which is why we call it an indicator of 'openness'). The five main export destinations of each country *i* are selected as follows: for each commercial partner *k* of country *i*, we calculate the average yearly share of *i*'s exports absorbed by country *k* in each year, and then take the average of this share over the whole sample period. We then select, for each country *i*, the five trade partners with the highest shares and calculate a weighted average of the measure of openness for these five main export destinations, with (fixed) weights proportional to average total population during the sample period.

5.1.3 Military expenditure

While the two instrumental variables described so far are related to exports, military spending is a sizable component of public expenditure that tends to be largely independent of the business cycle.[15] This instrument is imperfect, mainly because increases in military spending may tend to be offset, at least partially, by correspondent decreases in other components of public spending (Yang et al. 2014). However, as we will show presently, in our sample changes in military spending tend to correlate quite strongly with changes in overall public expenditure, suggesting that the crowding-out effect on other components of government spending, while probably present, is far from complete. It is worth noting that, *ceteris paribus*, the negative effect of military spending

14. The variable 'trade restrictions' is one of the components of the KOF Index of Globalization proposed by Dreher (2006) and updated in Dreher et al. (2008). We downloaded the most up-to-date version of the index from their website, globalization.kof.ethx.ch (accessed in October 2018).
15. For example, Nakamura and Steinsson (2014, p. 755) observe that in the US, while the regional distribution of military spending is highly political and thus likely to be affected by local economic conditions, 'national military spending is dominated by geopolitical events.'.

on other spending components would bias our estimates of the effect of autonomous demand downwards, thus making them more conservative.[16]

Of course, the identification assumption underlying the use of this instrumental variable is that changes in national military spending are largely exogenous to the domestic business cycle.

The two-stage least squares (2SLS) estimations that we perform in this section have the following general form:

$$I/Y_{i,t} = \alpha_i + \delta_t + \sum_{j=0}^{p} \beta_j \Delta z_{i,t-j} + \sum_{j=1}^{p} \gamma_j \Delta (I/Y)_{i,t-j} + \varepsilon_{i,t}$$

$$\begin{aligned} \Delta z_{i,t} = \rho_i + \theta_t + \sum_{j=0}^{q} \varphi_j \Delta US\,Demand_{i,t-j} + \sum_{j=0}^{q} \pi_j \Delta TPs\,openness_{i,t-j} + \\ + \sum_{j=0}^{q} \sigma_j \Delta Milex_{i,t-j} + \sum_{j=1}^{p} \omega_j \Delta (I/Y)_{i,t-j} + v_{i,t}. \end{aligned} \tag{2}$$

This specification implies that we are using only variation in autonomous-demand growth that is induced by changes in our three instrumental variables in order to estimate the effect of autonomous demand on the business investment share. We use the yearly data set to estimate equation (2), because data on our three instruments are not available on a quarterly basis.

5.2 First-stage estimation: effect of the external instruments on autonomous demand

Before formally estimating our first-stage regression, we plot each instrumental variable against the corresponding component of autonomous demand, in order to provide a transparent preliminary check of the relevance of our instruments (Figures 2–4).

Figure 2 reveals a strong positive relation between military expenditure and overall government spending (both taken in yearly growth rates). Figure 3 displays the positive effect of US demand for imports on the exports of other countries. Figure 4 plots the positive relation between export growth and our measure of export destinations' openness to trade. Specifically, in this case, we plot changes in export destinations' openness to trade versus four-years-ahead changes in exports. In this way, we account for the fact that domestic industries may react gradually to changes in trade partners' trade policy.

While the visual evidence of Figures 2 to 4 is only descriptive, it suggests that our instrumental variables are relevant, and for all of them the relation with autonomous demand has the expected sign.

Table 4 reports formal estimates of the first-stage regression, with aggregate autonomous-demand growth as the dependent variable. We include four lags of each instrumental variable, after having observed that further lags are never significant nor economically relevant, and two lags of the investment share, in order to reflect the 2SLS estimations that we will present briefly.

16. On the other hand, our estimates based on military spending may be biased upwards if the multiplier of military spending was significantly higher than the multiplier of the other components of public spending.

Table 4 First stage regressions (yearly data, 1970–2015)

	Dependent variable: autonomous-demand growth (ΔZ)			
	(1)	(2)	(3)	(4)
$\Delta Milex_t$	0.065**	0.096***	0.072***	0.103***
	(0.027)	(0.026)	(0.022)	(0.026)
$\Delta Milex_{t-1}$	0.039	0.079**	0.051**	0.048***
	(0.033)	(0.032)	(0.022)	(0.013)
$\Delta Milex_{t-2}$	−0.000	0.031	0.010	−0.001
	(0.027)	(0.020)	(0.017)	(0.020)
$\Delta Milex_{t-3}$	0.005	0.033*	0.010	−0.003
	(0.019)	(0.018)	(0.016)	(0.017)
$\Delta Milex_{t-4}$	0.001	0.022	−0.002	−0.011
	(0.020)	(0.023)	(0.016)	(0.019)
$\Delta US\ Demand_t$	0.389***	0.082*	0.046	0.069
	(0.132)	(0.043)	(0.072)	(0.049)
$\Delta US\ Demand_{t-1}$	−0.054	−0.076	−0.097	−0.113*
	(0.038)	(0.060)	(0.078)	(0.059)
$\Delta US\ Demand_{t-2}$	−0.030	−0.016	−0.034	−0.032
	(0.028)	(0.055)	(0.057)	(0.051)
$\Delta US\ Demand_{t-3}$	−0.053	−0.014	−0.045	−0.057
	(0.035)	(0.035)	(0.040)	(0.041)
$\Delta US\ Demand_{t-4}$	−0.121**	−0.010	−0.042	−0.041
	(0.059)	(0.042)	(0.039)	(0.037)
$\Delta TPs\ Openness_t$	0.676***	0.088	−0.022	0.025
	(0.247)	(0.240)	(0.275)	(0.259)
$\Delta TPs\ Openness_{t-1}$	0.498	−0.328**	−0.449**	−0.409
	(0.403)	(0.166)	(0.208)	(0.264)
$\Delta TPs\ Openness_{t-2}$	0.283	0.094	−0.047	0.026
	(0.276)	(0.372)	(0.371)	(0.329)
$\Delta TPs\ Openness_{t-3}$	1.077***	0.156	0.034	−0.005
	(0.359)	(0.244)	(0.291)	(0.308)
$\Delta TPs\ Openness_{t-4}$	0.600	0.711*	0.596	0.501
	(0.479)	(0.393)	(0.369)	(0.311)
F-Stat Excl. Instruments	72.44	63.62	50.40	68.52
p-value Excl. Instruments	0	2.0e-09	5.3e-07	0
Year FE	–	Yes	Yes	Yes
Country FE	–	–	Yes	Yes
Real interest rate	–	–	–	Yes
Profit share	–	–	–	Yes
Observations	691	691	691	604
Countries	19	19	19	19

Notes: Robust standard errors clustered by country and year in parentheses. Δ*US Demand* is 'jack-knifed' US imports growth interacted with the share of a country's exports going to the US (see main text); *TPs Openness* is a weighted average of the KOF measure of openness to trade for each country's five main export destinations (see main text); Δ*Milex* is real military expenditure growth. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Specifically, column 1 reports results from a simple pooled-OLS model. Column 2 includes year fixed effects, while column 3 adds country dummies, and column 4 controls for the real interest rate and the profit share. For all specifications, the null hypothesis that the instruments are not related to autonomous demand is rejected at the 1-percent significance level, confirming that the instruments are relevant.

5.3 Two-stage least squares (2SLS) estimates of the effect of autonomous demand

Table 5 displays results from the estimation of the IV model described by equation (2) on our yearly panel data set. We include two lags of autonomous demand and of the investment share in the second stage, based on the usual diagnostic tests and after having checked that further lags are not significant, and four lags of each instrumental variable in the first stage (in terms of equation (2), we are setting $p = 2$ and $q = 4$). This choice of lag length is also consistent with the Granger-causality analysis on quarterly data, where we included at most eight lagged quarters.

For the sake of comparison, the first four columns report estimates from a fixed-effects OLS model, which does not instrument autonomous-demand growth. Columns 5 to 8 report the 2SLS estimations, using our three instrumental variables for autonomous demand. For both the OLS and the 2SLS model, we present results from a pooled specification (columns 1 and 5); controlling for year effects (columns 2 and 6); controlling for two-way fixed effects (columns 3 and 7); controlling for two-way fixed effects, the profit share, and the real interest rate (columns 4 and 8). As in all estimations presented here, we cluster standard errors both by country and year.

We perform a Sargan–Hansen test of overidentifying restrictions to test the validity of our instruments. Rejection of the null hypothesis would indicate that the instruments are not valid. Reassuringly, the p-value for this test varies between 0.32 and 0.75 in our IV specifications, which is consistent with our instrumental variables being exogenous.

Across all specifications, autonomous demand-growth has a positive, economically relevant and statistically significant effect on the ratio of business investment to GDP. The null hypothesis that autonomous-demand growth has no effect is rejected at least at the 10-percent significance level in all specifications (and at the 5-percent level in all specifications but one). The long-run effect of a permanent increase in autonomous-demand growth on the investment share implied by the IV estimations lies between 0.33 and 1.9 points of GDP.

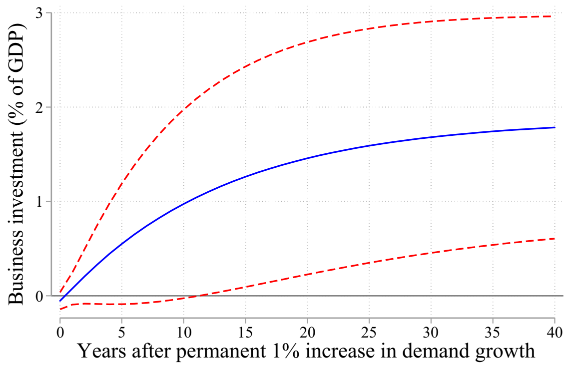
As already discussed, the inclusion of the real interest rate and the profit share as control variables (as shown in columns 4 and 8 of Table 5) is an exercise to be interpreted with caution: both variables are endogenous, and this is likely also to bias the coefficients for the effect of autonomous demand. (Although of course it is reassuring that including these two variables does not alter the main results.) Moreover, given that the number of observations per country is much lower than in the quarterly data set (fewer than 50 on average; only 23 for some countries), the specifications including country fixed effects may be affected by Nickell bias (Nickell 1981). For these reasons, our preferred specifications are those in columns 5 and 6, which do not include country effects (thus avoiding Nickell bias) nor endogenous control variables (thus avoiding endogeneity bias). In these preferred specifications, the long-run effect of autonomous demand is between 1.5 and 1.9 points of GDP.

Figure 5 plots the impulse-response function (IRF) implied by our preferred IV specification (the fixed-effects model with time dummies). This displays the time path of the effect of a permanent 1-percentage-point increase in autonomous-demand growth on the business investment share, based on the coefficients reported in Table 5.

Table 5 Effect of autonomous demand on the business investment share – instrumental-variables estimates (yearly data, 1970–2015)

	Dependent variable: business investment share (I/Y)							
	OLS				2SLS			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔZ_t	0.015	−0.012	−0.018	0.029	0.118**	−0.053	−0.072	−0.031
	(0.030)	(0.021)	(0.019)	(0.021)	(0.048)	(0.055)	(0.057)	(0.046)
ΔZ_{t-1}	0.052***	0.051***	0.047***	0.041*	−0.005	0.194***	0.182***	0.106***
	(0.012)	(0.013)	(0.009)	(0.023)	(0.028)	(0.073)	(0.061)	(0.033)
ΔZ_{t-2}	−0.026*	0.001	−0.003	−0.018	−0.049**	−0.037	−0.060	−0.001
	(0.016)	(0.013)	(0.012)	(0.017)	(0.020)	(0.049)	(0.057)	(0.060)
F-Stat (H_0 = no effect)	21.70	22.04	38.70	30.27	14.52	7.315	9.250	37.02
p-value F-stat.	7.6e-05	6.4e-05	2.0e-08	1.2e-06	0.002	0.062	0.026	4.6e-08
p-value overid.	–	–	–	–	0.318	0.707	0.665	0.754
Long-run effect of ΔZ	1.081	1.038	0.225	0.371	1.531	1.873	0.336	0.482
	(0.499)	(0.577)	(0.103)	(0.090)	(0.731)	(0.651)	(0.420)	(0.366)
Persistence of I/Y	0.962	0.962	0.885	0.862	0.958	0.945	0.852	0.845
	(0.008)	(0.008)	(0.017)	(0.031)	(0.008)	(0.024)	(0.034)	(0.032)
Long-run effect RIR	–	–	–	−0.333	–	–	–	−0.235
	–	–	–	(0.082)	–	–	–	(0.148)
Long-run effect PS	–	–	–	0.0975	–	–	–	0.155
	–	–	–	(0.099)	–	–	–	(0.094)
Country FE	–	–	Yes	Yes	–	–	Yes	Yes
Year FE	–	Yes	Yes	Yes	–	Yes	Yes	Yes
Real interest rate	–	–	–	Yes	–	–	–	Yes
Profit share	–	–	–	Yes	–	–	–	Yes
Observations	928	928	928	671	691	691	691	604
Countries	19	19	19	19	19	19	19	19

Notes: Robust standard errors clustered by country and year in parentheses. Z is the natural log of autonomous demand. I/Y is the ratio of business investment to GDP. All regressions control for two lags of the dependent variable. In the 2SLS models, autonomous demand is instrumented with 'jack-knifed' US demand for imports interacted with the share of exports going to the US (see main text), a weighted average of the KOF measure of openness to trade for each country's five main export destinations (see main text), and real military expenditure. 'p-value overid.' is the p-value from a Hansan–Sargan test of overidentifying restrictions. 'F-stat (H_0 = no effect') is the F-stat for the joint test that all coefficients on autonomous-demand growth are equal to zero. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.



Note: Dotted lines represent 90-percent confidence intervals calculated from robust standard errors clustered by country and year.

Figure 5 Dynamic effect of a permanent 1-percentage-point increase in autonomous-demand growth (instrumental-variables estimation; yearly panel 1970–2015)

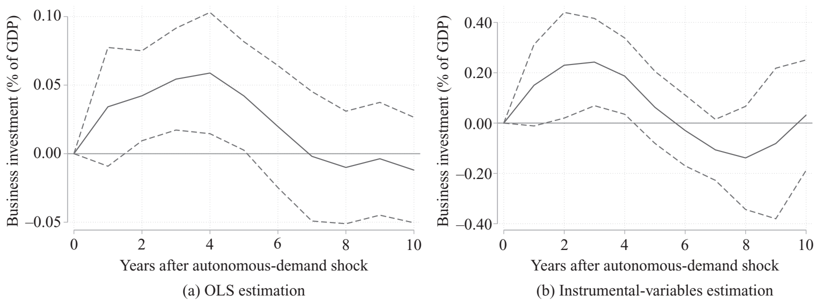
The estimated IRF indicates a gradual increase in the investment share after a permanent positive autonomous-demand shock, with *I*/*Y* eventually reaching its new (higher) equilibrium.

As a further robustness test, we have also tried excluding housing investment from the definition of autonomous demand.[17] There are two motivations for this test. First, our exogenous instruments capture variation in government spending and exports, not housing investment, therefore a change in results due to excluding housing investment would signal some problem. Second, some have argued that housing investment should not be included in autonomous demand, because it is largely induced by income growth. When excluding housing investment, our 2SLS results are qualitatively unchanged. Given the possible non-linearities suggested by Figures 2–4, we have also tried including quadratic terms in the first stage. Results are unchanged also in this case.[18]

Of course, the time path of the effect depicted in Figure 5 relies heavily on our parametric specification of the autoregressive process followed by the investment share. We are tracing the time path of the effect of an autonomous-demand shock by extrapolating the observed persistence of the investment share into the future. Moreover, this procedure implies that we are simulating the effect of a *permanent* increase in the growth rate of autonomous demand. While this is of primary interest for our analysis, we are also interested in assessing the effect of a temporary increase in the growth rate of autonomous demand.

For these reasons, in the next sub-section we present semi-parametric estimates of the dynamic effect of an autonomous-demand shock based on local projections (Jordà 2005). These do not assume any parametric model for the dynamics of the outcome of interest and can be interpreted as tracing the time-path of the effect of a *temporary* increase in autonomous-demand growth.

17. We are grateful to an anonymous referee for suggesting this robustness test.
18. Results not reported for reasons of space, but available upon request.



Note: Dotted lines represent 90-percent confidence intervals calculated from robust standard errors clustered by country and year.

Figure 6 Dynamic effect of a temporary 1-percentage-point increase in autonomous-demand growth (local projections; yearly panel 1970–2015)

5.4 Semi-parametric estimates using local projections (LPs)

Our LPs estimates of the effect of autonomous demand on the investment share consist of a series of regressions with the following form:

$$I/Y_{i,t+h} = \alpha_i^h + \delta_t^h + \sum_{j=1}^{2} \gamma_j^h (I/Y)_{i,t-j} + \beta^h \Delta Z_{i,t} + \varepsilon_{i,t+h} \qquad \text{for } h = 1, \ldots, n. \quad (3)$$

We estimate LPs at a ten-year horizon (n = 10), using both a simple OLS model (likely biased by endogeneity) and a 2SLS model that uses the three instrumental variables that we have introduced in this section.

The estimated dynamic effect of autonomous demand obtained from equation (3) does not rely on parametric assumptions about the autoregressive structure of the variables of interest (unlike the dynamic-panel models presented so far). Moreover, it estimates the effect of a *temporary* shock to the growth rate of autonomous demand.

The resulting time path of the effect of autonomous demand is displayed in Figure 6, where panel (a) displays OLS estimations and panel (b) displays 2SLS estimations which control for endogeneity through instrumental variables. In both specifications, a temporary 1-percentage-point increase in the growth rate of autonomous demand tends to cause a gradual temporary increase in the investment share, with the effect reaching a peak after four years and then gradually reversing. While the effect is positive, significant and remarkably persistent in both the OLS and the IV specifications, this analysis suggests that endogeneity tends to lead to underestimation of the effect of interest: at its peak, the effect is around 0.06 percentage points of GDP in the OLS estimation but around 0.25 points of GDP in the 2SLS specification.

6 DISCUSSION

What are the macroeconomic implications of a positive relation between autonomous demand and the share of business investment in GDP? In what follows, we relate our empirical results to the recently reignited debate on hysteresis (sub-section 6.1). We then assess the compatibility of our findings with different macroeconomic models (sub-section 6.2). We provide here an informal discussion of this latter issue, while a more detailed exposition with some simple formalization is reported in Appendix 3 (available online at https://doi.org/10.4337/roke.2020.03.10).

6.1 The influence of demand on business investment as a source of hysteresis

A growing strand of literature explores the possibility that shocks to actual output have an impact on long-run economic dynamics – referred to as hysteresis (Blanchard and Summers 1986; Ball 1999; 2009; 2014; Schettkat and Sun 2009). Various channels have been investigated: wage-setting asymmetries between insiders and outsiders (Blanchard and Summers 1986); monetary policy (Schettkat and Sun 2009); the interaction of shocks with 'poor' labor market institutions (Blanchard and Wolfers 2000); financial and political crises (Cerra and Saxena 2008); endogenous productivity and R&D technology adoption (Comin and Gertler 2006); aggregate demand through multiple routes (see various works of Laurence Ball).

Our results are informative for this debate, because they provide evidence in favor of the hypothesis that the effect of demand on capital accumulation is strong enough to be a major potential source of hysteresis. As we have shown, autonomous-demand shocks have a sizable effect on the share of productive resources devoted to capital accumulation.

That a higher investment share has implications for long-run output is a result that holds independently of the assumed aggregate production function. Obviously, with fixed-coefficient production, potential output is simply proportional to the capital stock. But the investment share is relevant for long-run output also under a Neoclassical production function. In the Neoclassical exogenous growth model (Solow 1956), a higher investment share is associated with a higher equilibrium level of output per capita; in endogenous growth models (for example, Romer 1986), a higher investment share is associated with a higher equilibrium rate of growth.[19] Of course, in both exogenous and endogenous Neoclassical growth theory, it is not aggregate demand but exogenous individual preferences ('thriftiness') which determine the investment share, contrarily to our empirical results and ruling out hysteresis.

6.2 Autonomous demand and the investment share in alternative theoretical frameworks

Our empirical findings are helpful in assessing alternative macroeconomic models. Indeed, different models yield starkly different predictions about the effect of demand shocks on the business investment share.

6.2.1 The canonical Neo-Keynesian model

A positive impact of autonomous demand on the business investment share is certainly inconsistent with supply-led models where demand, whether in level or growth terms, does not have a persistent, long-run independent influence. This is the case

19. This mechanism can operate directly by affecting capital per worker (Romer 1986) or through the pattern of technological progress (Lucas 1988; Romer 1990). See also Cesaratto (1999) for a critical discussion.

with the canonical New Keynesian three-equations model (Clarida et al. 1999; Carlin and Soskice 2015), in which equilibrium output is supply-side determined. If autonomous demand increases, the monetary rule of the model prescribes a raise in the rate of interest, to tame the ensuing inflation. Consequently, private investment is crowded-out and its share in GDP decreases. Given that a standard New Keynesian model is unable to explain the results of our empirical analysis, in what follows we turn our attention to alternative approaches.

6.2.2 Classical models

'Classical' models, like those presented by Duménil and Lévy (1999), Park (2000), and Shaikh (2009), produce results that in this respect are very similar to those of the canonical New Keynesian model. In Duménil and Lévy (1999), the economy is assumed to converge to a 'Classical' equilibrium, with capacity utilization equal to its desired degree and no inflation. For a given level of technology and real wage, the rate of profit is fully determined, and so is the rate of growth, which is assumed to be a function of the profit rate. Along the equilibrium path, a surge in demand generates a degree of utilization above the normal one, and thus generates inflation. The central bank is assumed to react by reducing the money supply (as in Duménil and Lévy 1999) or by increasing the interest rate, with the consequence of displacing the economy on a new equilibrium path where normal utilization is restored but growth is slower, and the investment share is lower.

While the original formulation by Duménil and Lévy does not consider explicitly autonomous demand, this is introduced by Park (2000) in his version of the model. The conclusions are similar: an acceleration of autonomous demand leads to a slowdown of the economy and an increase in the share of autonomous demand in GDP, mirrored by a lower share of private investment. The Classical–Harrodian model proposed by Shaikh (2009) produces analogous results. Only under restrictive conditions do increases in autonomous-demand growth result in higher investment share and output growth. A surge in autonomous demand usually turns out to be 'too much of a good thing' (ibid., p. 469).

6.2.3 The Neo-Kaleckian model

Demand-led growth models, in which aggregate demand influences long-run outcomes, are natural candidates to explain our results. Notice, however, that in a baseline Neo-Kaleckian model (Amadeo 1986) – where aggregate demand only comprises induced consumption and investment – the investment share is supply-side determined, with no role for demand. The ratio of investment to GDP is indeed equal to the capitalists' marginal propensity to save times the profit share, which are both assumed to be exogenously given. In an otherwise standard Neo-Kaleckian model that includes autonomous demand, on the other hand, autonomous-demand growth does have an impact on the investment share, but a *negative* one (as we show in Appendix 3, available online at https://doi.org/10.4337/roke.2020.03.10). The reason behind this result is that, in these models, capacity utilization is assumed to be flexible in the long run. Demand shocks are thus fully accommodated by changes in the rate of capacity utilization: a permanent acceleration in autonomous demand would cause a permanently higher rate of utilization. Given that firms, in this framework, do not attempt to restore a cost-minimizing rate of utilization,[20] investment growth does not catch up and a lower investment share persists.

6.2.4 Harrodian models

Does a benchmark Harrodian model, of the type presented in Skott (2010), predict a positive effect of autonomous-demand shocks on the investment share, consistent with our findings? Skott (2016) argues that it does. Commenting on the US time-series results presented in Girardi and Pariboni (2016), he writes that 'changes in the growth rate affect the share of investment in income. This result is what a simple Harrodian model would predict: if the utilization rate fluctuates around a constant desired value, an increase in the growth rate must raise the investment–output ratio' (Skott 2016, p. 6, n. 8).

In what follows, we argue that the answer is more nuanced: the simplest version of the Harrodian model that Skott refers to is not consistent with our findings; its 'Kaldor–Marshall' extension, however, is arguably able to explain our results, although the implied channels of causality are not fully consistent with some aspects of our empirical analysis.

First, it is worthwhile noticing that Skott is talking about the relation between the *output* growth rate and the investment share, while our empirical results (both in our 2016 article, which Skott refers to, and here) concern the impact of changes in *autonomous-demand* growth on the investment share. Of course, one can argue that demand growth must be in line with output growth. However, the direction of causality is important, as we will argue presently.

To understand and engage with Skott's argument, we can look at the relation between demand and the investment share implied by the benchmark Harrodian model presented in Skott (2010). In this model, an increase in the profit share raises both the investment share and the growth rate of the economy (see Appendix 3 for more detail, available online at https://doi.org/10.4337/roke.2020.03.10). In this generic sense, Peter Skott is certainly right: the model predicts a positive correlation between demand growth and the investment share. However, in Skott's Harrodian model the *primum movens* is a shift in income distribution in favor of capital. The correlation between demand and the investment share is thus spurious: both variables are driven by a third one (the profit share). The simple Harrodian model that Skott refers to does *not* predict a causal effect of exogenous changes in (autonomous) demand on the investment share (which is what we find in our work). What it predicts is that both demand and the investment share are driven by exogenous movements in the profit share.

A different argument applies to the Kaldor–Marshall extension to the baseline Harrodian model, proposed by Skott in the same article (Skott 2010). This specification can predict a positive effect of demand shocks on the investment share, consistently with our baseline regressions. In this Kaldor–Marshall model, income distribution is endogenously determined by the rate of growth, with the profit share increasing when the output path accelerates (as in the 'Cambridge equation' growth models). Therefore, a demand expansion increases the profit share, which in turn causes an increase in the investment share. While the general result is consistent with our

20. Skott (2012), Cesaratto (2015), and Girardi and Pariboni (2019) discuss this assumption critically, from both a theoretical and an empirical point of view.

findings, however, the implied mechanism is not. In the regressions reported in Tables 5 and A3 (available online at https://doi.org/10.4337/roke.2020.03.10) we control for the profit share and we still find a positive effect of autonomous demand. If the influence of (autonomous) demand on the investment share worked through (endogenous) changes in the profit share, after controlling for the latter the effect should disappear.[21]

6.2.5 Supermultiplier models

The positive effect of autonomous demand on the investment share is consistent with autonomous-demand-led growth models in which capacity adjusts to demand in the long run. A model of this type – dubbed the 'Sraffian supermultiplier' – has been proposed by Serrano (Serrano 1995; Freitas and Serrano 2015). More recently, Allain (2015) and Lavoie (2016) have provided similar models, in the form of amended versions of the Neo-Kaleckian model. Fazzari et al. (2018) and Palley (2019) enrich the supermultiplier framework with an explicit consideration of labor market dynamics, while Brochier and Macedo e Silva (2019) integrate it within a stock–flow consistent model.

In these theoretical constructions, a speeding-up in autonomous demand is initially accommodated by a degree of capacity utilization higher than the desired one. Restoration of a production carried over with the desired intensity of capital utilization requires that investment, for a certain span of time, grows faster than autonomous demand and output, which explains the higher equilibrium investment share. In Appendix 3 (available online at https://doi.org/10.4337/roke.2020.03.10), we provide a formal stylized model drawing on this literature, showing that in this framework a higher growth rate of autonomous demand implies a higher investment share.

7 CONCLUSIONS

In this paper, we have provided evidence of a positive influence of autonomous-demand growth on the share of business investment in GDP. According to our results, a 1-percentage-point permanent increase in autonomous-demand growth increases the investment share by more than 1.5 percentage points of GDP in the long run. This finding appears robust to the use of alternative techniques and specifications.

First, we have employed dynamic-panel Granger-causality tests to show that changes in autonomous-demand growth tend to be followed by same-sign changes in the share of business investment in GDP. This association is robust to the inclusion of two-way fixed effects, the interest rate, and the profit share as control variables.

To tackle endogeneity issues due to the influence of macroeconomic conditions on autonomous demand, we have employed an instrumental-variables approach. We have used three external instruments for autonomous demand in a country *i*: US aggregate demand for imports (excluding imports from country *i*) interacted with the share of *i*'s exports absorbed by the US; weighted-average openness to trade of the five main export destinations of country *i*; and military expenditure. Using only variation in autonomous demand that is driven by these three instrumental variables, we confirmed a positive association between autonomous-demand growth and the investment share.

21. It is fair to note that Skott's (2016) comment refers to Girardi and Pariboni (2016), in which we do not add the profit share as a control variable.

The results of these IV estimations suggest that the positive relation between autonomous-demand growth and the business investment share is not spurious but reflects a causal effect of demand on capital accumulation. These findings are also robust to using semi-parametric local projections (Jordà 2005) instead of dynamic-panel models.

Our finding that demand factors affect the share of national output devoted to capital accumulation is relevant for the hysteresis debate. It supports the view that the influence of demand on business investment can be a major source of hysteresis.

More generally, our findings are at odds with macroeconomic models in which the level and the growth rate of potential output are fully determined by supply-side forces, as we have shown in our discussion of the canonical New Keynesian three-equations model and of the Classical growth model of Duménil and Lévy (1999). They are inconsistent also with those demand-led growth models in which capacity does not fully adjust to demand in the long run, such as the standard Neo-Kaleckian model. On the other hand, the positive response of the investment share to variations in demand growth is precisely the mechanism which guarantees the convergence of the degree of capacity utilization to its normal level in demand-led models of the supermultiplier type (Freitas and Serrano 2015; Lavoie 2016).

REFERENCES

Allain, O. (2015), 'Tackling the instability of growth: a Kaleckian–Harrodian model with an autonomous expenditure component,' *Cambridge Journal of Economics*, 39(5), 1351–1371.

Amadeo, E.J. (1986), 'The role of capacity utilisation in long-period analysis,' *Political Economy*, 2(2), 147–160.

Ball, L. (1999), 'Aggregate demand and long-run unemployment,' *Brookings Papers on Economic Activity*, 30(2), 189–252.

Ball, L. (2009), 'Hysteresis in unemployment: old and new evidence,' NBER Working Paper 14818.

Ball, L. (2014), 'Long-term damage from the Great Recession in OECD countries,' *European Journal of Economics and Economic Policies: Intervention*, 11(2), 149–160.

Blanchard, O. and L. Summers (1986), 'Hysteresis and the European unemployment problem,' *NBER Macroeconomics Annual*, 15–89.

Blanchard, O. and J. Wolfers (2000), 'The role of shocks and institutions in the rise of European unemployment: the aggregate evidence,' *Economic Journal*, 110(462), 1–33.

Blomström, M., R.E. Lipsey, and M. Zejan (1996), 'Is fixed investment the key to economic growth?' *The Quarterly Journal of Economics*, 111(1), 269–276.

Brochier, L. and A.C. Macedo e Silva (2019), 'A supermultiplier stock-flow consistent model: the "return" of the paradoxes of thrift and costs in the long run?' *Cambridge Journal of Economics*, 43(2), 413–442.

Caballero, R.J. (1999), 'Aggregate investment,' in J.B. Taylor and M. Woodford (eds), *Handbook of Macroeconomics*, New York: Elsevier, pp. 813–862.

Cameron, A.C., J.B Gelbach, and D.L. Miller (2011), 'Robust inference with multiway clustering,' *Journal of Business & Economic Statistics*, 29(2), 238–249.

Carlin, W. and D.W. Soskice (2006), *Macroeconomics: Imperfections, Institutions and Policies*, Oxford: Oxford University Press.

Carlin, W. and D.W. Soskice (2015), *Macroeconomics: Institutions, Instability and the Financial System*, Oxford: Oxford University Press.

Cerra, V. and S.C. Saxena (2008), 'Growth dynamics: the myth of economic recovery,' *American Economic Review*, 98(1), 439–457.

Cesaratto, S. (1999), 'Savings and economic growth in Neoclassical theory,' *Cambridge Journal of Economics*, 23(6), 771–793.

Cesaratto, S. (2015), 'Neo-Kaleckian and Sraffian controversies on the theory of accumulation,' *Review of Political Economy*, 27(2), 154–182.

Cesaratto, S., F. Serrano, and A. Stirati (2003), 'Technical change, effective demand and employment,' *Review of Political Economy*, 15(1), 33–52.

Chirinko, R.S. (1993), 'Business fixed investment spending: modeling strategies, empirical results and policy implications,' *Journal of Economic Literature*, 31(4), 1875–1911.

Clarida, R, J. Galí, and M. Gertler (1999), 'The science of monetary policy: a New Keynesian perspective,' *Journal of Economic Literature*, 37(4), 1661–1707.

Comin, D. and M. Gertler (2006), 'Medium-term business cycles,' *American Economic Review*, 96(3), 523–551.

Dreher, A. (2006), 'Does globalization affect growth? Evidence from a new index of globalization,' *Applied Economics*, 38(10), 1090–1110.

Dreher, A., N. Gaston, and P. Martens (2008), *Measuring Globalisation – Gauging its Consequences*, New York: Springer.

Duménil, G. and G. Lévy (1999), 'Being Keynesian in the short term and classical in the long term: the traverse to classical long-term equilibrium,' *The Manchester School*, 67(6), 684–716.

Dutt, A.K. (2011), 'The role of aggregate demand in classical–Marxian models of economic growth,' *Cambridge Journal of Economics*, 35(2), 357–382.

Dutt, A.K. (2013), 'Government spending, aggregate demand, and economic growth,' *Review of Keynesian Economics*, 1(1), 105–119.

Fatás, A. and L.H. Summers (2016), 'The permanent effects of fiscal consolidations,' NBER Working Paper 22374.

Fazzari, S., P. Ferri, and A.M. Variato (2018), 'Demand-led growth and accommodating supply,' FMM Working Paper 15.

Freitas, F. and F. Serrano (2015), 'Growth rate and level effects, the stability of the adjustment of capacity to demand and the Sraffian supermultiplier,' *Review of Political Economy*, 27(3), 258–281.

Frenkel, J. (2012), 'The pro-cyclicalists: fiscal austerity vs. stimulus,' *Vox*, 7 August, available at: http://voxeu.org/article/procyclicalists-fiscal-austerity-vs-stimulus.

Frölich, M. (2008), 'Parametric and non-parametric regression in the presence of endogenous control variables,' *International Statistical Review,* 76(2), 214–227.

Girardi, D. and R. Pariboni (2015), 'Autonomous demand and economic growth: some empirical evidence,' Centro Sraffa Working Paper 13, October.

Girardi, D. and R. Pariboni (2016), 'Long-run effective demand in the US economy: an empirical test of the Sraffian supermultiplier model,' *Review of Political Economy*, 28(4), 523–544.

Girardi, D. and R. Pariboni (2019), 'Normal utilization as the adjusting variable in Neo-Kaleckian growth models: a critique,' *Metroeconomica*, 70(2), 341–358.

Goldsmith-Pinkham, P., I. Sorkin, and H. Swift (2018), 'Bartik instruments: what, when, why, and how,' NBER Working Paper 24408.

Granger, C.W.J. (1980), 'Testing for causality: a personal viewpoint,' *Journal of Economic Dynamics and Control*, 2(1), 329–352.

Hein, E., M. Lavoie, and T. van Treeck (2012), 'Harrodian instability and the "normal rate" of capacity utilization in Kaleckian models of distribution and growth: a survey,' *Metroeconomica*, 63(1), 139–169.

Iacoviello, M. and M. Pavan (2011), 'Housing and debt over the life cycle and over the business cycle,' Board of Governors of the Federal Reserve System, International Finance Discussion Paper 1032.

Im, K.S., M.H. Pesaran, and Y. Shin (2003), 'Testing for unit roots in heterogeneous panels,' *Journal of Econometrics*, 115(1), 53–74.

Jordà, O. (2005), 'Estimation and inference of impulse responses by local projections,' *American Economic Review*, 95(1), 161–182.

Judson, R. and A. Owen (1999), 'Estimating dynamic panel data models: a guide for macroeconomists,' *Economics Letters*, 65(1), 9–15.

Lavoie, M. (2015), 'Book review: Wendy Carlin and David Soskice, Macroeconomics: Institutions, Instability, and the Financial System,' *European Journal of Economics and Economic Policies: Intervention*, 12(1), 135–142.

Lavoie, M. (2016), ‘Convergence towards the normal rate of capacity utilization in Neo-Kaleckian models: the role of non-capacity creating autonomous expenditures,’ *Metroeconomica*, 67(1), 172–201.

Lavoie, M. and P. Kriesler (2007), ‘Capacity utilization, inflation, and monetary policy: the Duménil and Lévy macro model and the New Keynesian consensus,’ *Review of Radical Political Economy*, 39(4), 586–598.

Levin, A., C. Lin, and C.J. Chu (2002), ‘Unit root tests in panel data: asymptotic and finite-sample properties,’ *Journal of Econometrics*, 108(1), 1–24.

Lucas, R.E. (1988), ‘On the mechanics of economic development,’ *Journal of Monetary Economics*, 22(1), 3–42.

Nakamura E. and J. Steinsson (2014), ‘Fiscal stimulus in a monetary union: evidence from US regions,’ *American Economic Review*, 104(3), 753–792.

Nickell, S. (1981), ‘Biases in dynamic models with fixed effects,’ *Econometrica*, 19(6), 1417–1426.

Palley, T. (2019), ‘The economics of the super-multiplier: a comprehensive treatment with labor markets,’ *Metroeconomica*, 70(2), 325–340.

Park, M.S. (2000), ‘Autonomous demand and the warranted rate of growth,’ *Contributions to Political Economy*, 19(1), 1–18.

Reifschneider, D., W. Wascher, and D. Wilcox (2015), ‘Aggregate supply in the United States: recent developments and implications for the conduct of monetary policy,’ *IMF Economic Review*, 63(1), 71–109.

Romer, P.M. (1986), ‘Increasing returns and long-run growth,’ *Journal of Political Economy*, 94(5), 1002–1037.

Romer, P.M. (1990), ‘Endogenous technological change,’ *Journal of Political Economy*, 98(5), 71–102.

Schettkat, R. and R. Sun (2009), ‘Monetary policy and European unemployment,’ *Oxford Review of Economic Policy*, 25(1), 94–108.

Serrano, F. (1995), ‘Long period effective demand and the Sraffian Supermultiplier,’ *Contributions to Political Economy*, 14, 67–90.

Shaikh, A. (2009), ‘Economic policy in a growth context: a Classical synthesis of Keynes and Harrod,’ *Metroeconomica*, 60(3), 455–494.

Skott, P. (2010), ‘Growth, instability and cycles: Kaleckian and Harrodian models of accumulation and income distribution,’ in M. Setterfield (ed.), *Handbook of Alternative Theories of Economic Growth*, Cheltenham, UK and Northampton, MA: Edward Elgar Publishing, pp. 108–131.

Skott, P. (2012), ‘Theoretical and empirical shortcomings of the Kaleckian investment function,’ *Metroeconomica*, 63(1), 109–138.

Skott, P. (2016), ‘Autonomous demand, Harrodian instability and the supply side,’ UMass Amherst Economics Department Working Papers Series 2016-16.

Solow, R.M. (1956), ‘A contribution to the theory of economic growth,’ *The Quarterly Journal of Economics*, 70(1), 65–94.

Sorensen, B.E., L. Wu, and O. Yosha (2001), ‘Output fluctuations and fiscal policy: US state and local governments 1978–1994,’ *European Economic Review*, 45(7), 1271–1310.

Tavani, D. and L. Zamparelli (2017), ‘Government spending composition, aggregate demand, growth, and distribution,’ *Review of Keynesian Economics*, 5(2), 239–258.

Yang, W., J. Fidrmuc, and S. Ghosh (2014), ‘Using military build-ups to capture fiscal shocks: a reassessment,’ CESifo Working Papers Series 4689.

Yellen, J. (2016), ‘Macroeconomic research after the crisis,’ Remarks given at ‘The Elusive “Great” Recovery: Causes and Implications for Future Business Cycle Dynamics,’ 60th Annual Economic Conference Sponsored by the Federal Reserve Bank of Boston, Boston, Massachusetts, available at: http://www.federalreserve.gov/newsevents/speech/yellen20161014a.pdf.