可再生能源政策与社会资本参与
——基于“一带一路”国家能源投资项目的研究

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摘　要：本文以2010~2019年社会资本参与的“一带一路”45个国家1293个能源投资项目为研究样本，探究可再生能源政策吸引社会资本绿色投资的有效性。实证结果表明：一国可再生能源政策可以显著促进社会资本做出绿色投资决策并增加投资规模。区分可再生能源发展阶段的回归结果显示，可再生能源政策对社会资本绿色投资的吸引作用仅体现在处于起步期的可再生能源市场，而当市场处于成长成熟期后，融资市场成为社会资本绿色投资的主要驱动力。可再生能源政策可能通过推动可再生能源市场开拓来影响社会资本绿色投资规模，但对可再生能源技术创新的促进效应暂未显现。因此，推动“一带一路”绿色发展，不仅要优化国家可再生能源政策体系，而且要充分拓宽可再生能源领域融资渠道。

关键词：“一带一路”　可再生能源政策　社会资本　绿色投资

JEL 分类号：O13, P28, Q48

一、引言

2013年，习近平主席提出“一带一路”倡议，旨在打造全球开放合作平台，为世界各国发展提供新机遇和新动力。近年来，随着全球环境治理体系的进一步完善，以碳中和为核心的绿色发展目标正成为各国的共同追求。据能源与气候智库(ECIU)的统计，全球已有132个国家及地区提出碳中和目标，中国也承诺于2030年前实现碳达峰，2060年前实现碳中和。在全球低碳可持续发展的大背景下，绿色逐渐成为新时期“一带一路”倡议发展的鲜明主题。2017年5月环境保护部、外交部、发展改革委、商务部联合发布的《关于推进绿色“一带一路”建设的指导意见》明确提出构建绿色丝绸之路的倡议。如何利用绿色投资推动“一带一路”沿线国家的可持续发展成为新时期“一带一路”倡议的主要议题。基础设施互联互通作为拉动经济的主要支撑点，是“一带一路”倡议的重点合作领域。发达的基础设施体系能够有力地提高地区交通便利性，吸引资本流入并推动国家经济增长。然而，基础设施具有投资规模大、建设和运营周期长、投资不可逆的特点，以电力、能源领域为主的基础设施

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项目可能会在建设过程中破坏当地植被、产生噪声污染，其运营过程中释放的大量二氧化碳更会对当地环境产生严重的负面效应。习近平主席在第二届“一带一路”国际合作高峰论坛上强调“把绿色作为底色，推动绿色基础设施建设、绿色投资、绿色金融”。可见，引导基础设施领域的可持续发展，提高可再生能源的使用规模，对于“一带一路”的绿色发展至关重要。

当前“一带一路”沿线国家低迷的经济形势和短缺的建设资金问题制约了多数国家的可再生能源项目建设。《“一带一路”国家绿色投资和碳排放路径的量化报告》显示，“一带一路”沿线国家的绿色投资额需要在2016~2030年增加至少12万亿美元，才有可能实现《巴黎协定》中约定的气候目标（ClimateWorks Foundation, 2019）。财政资金是基础设施建设的主要传统资金来源，但全球发展中经济体在后金融危机时代面临财政赤字和政府去杠杆等压力，新冠肺炎疫情冲击带来的全球经济衰退更让“一带一路”沿线各国的财政系统面临巨大挑战，因此单纯依赖各国的财政体系已无法弥补可再生能源建设的巨大资金缺口，现有金融市场、国际金融机构的支持也不能完全改变基建领域融资难的现状（徐奇渊等，2017）。因此，解决“一带一路”沿线国家可再生能源发展的资金供给问题，迫切需要构建投资主体多元化的投融资机制，鼓励更多社会资本参与到全球可再生能源项目建设中。然而，经济发展越落后的国家对私人资本的吸引力越小（Maianne et al., 2021），而且能源项目作为一个外部性极强的公共产品，其准入门槛较高、投资回报率较低，民间资本在缺乏政策支持的情况下很难主动投身于可再生能源项目的建设。世界银行PPI数据库的数据显示，社会资本对 “一带一路”沿线国家可再生能源投资规模在近二十年呈现逐步上升的趋势，但近年来增速有所放缓。如何吸引民间资本推动“一带一路”的绿色发展是一个亟需解决的问题。

自绿色丝绸之路倡议提出以来，中国对外投资企业和社会资本方以实际行动响应国家号召，不断加大对可再生能源行业的投资规模，但“一带一路”的绿色发展不仅需要中国带头参与，更需要沿线各国的积极合作。把绿色作为“一带一路”倡议的底色，既是“一带一路”倡议提出的初心，也是各国参与“一带一路”建设的共识。此外，可再生能源投资初期具有高风险、高成本、低回报的特点，因此相较于其他基建领域投资而言，可再生能源投资更依赖于东道国政府补助等鼓励性政策的支持。当前“一带一路”沿线各国相继出台鼓励可再生能源发展的政策，但上述政策是否会对社会资本绿色投资决策产生影响仍未可知。随着全球各国对可再生能源认识的逐步深入，可再生能源政策类型也逐渐多元化，“一带一路”沿线国家可再生能源市场也由于技术成熟度和可再生能源禀赋等因素处于不同的发展阶段，不同的可再生能源政策和发展阶段对社会资本投资规模是否会产生差异化影响也是本文想要探讨的问题。因此，本文重点研究以下四个问题：第一，东道国支持可再生能源市场的政策是否会影响社会资本的绿色投资规模？ 第二，政策吸引社会资本绿色投资的有效性是否会在处于可再生能源发展不同阶段的国家呈现差异化特点？第三，不同类型的可再生能源政策是否会对社会资本绿色投资的积极性产生差异化影响？第四，可再生能源政策对社会资本绿色投资

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的可能影响途径有哪些？回答以上问题将有助于探索当前可再生能源政策有效性，最终提出有针对性的策略提升社会资本参与“一带一路”绿色发展的积极性，缓解沿线国家绿色能源投资短缺问题，推动绿色丝绸之路的建设。

本文以“一带一路”沿线45个国家2010~2019年的1293个能源投资项目为主要研究对象，使用Probit模型和截面模型对混合截面数据进行回归，得到的主要结论如下：一国可再生能源支持政策可以显著促进社会资本做出绿色投资决策并增加投资规模。区分可再生能源发展阶段的回归结果显示，可再生能源政策对社会资本绿色投资的吸引作用仅体现在处于起步期的可再生能源市场，而当一国可再生能源市场进入成长成熟期后，融资市场自由度成为社会资本绿色投资的主要驱动力，市场在资源配置中的决定性作用逐渐凸显。异质性分析发现，以可再生能源长期战略规划为代表的宏观政策有助于提高社会资本的可再生能源投资规模，而以可再生能源竞标拍卖政策为代表的市场激励型政策对处于起步期的可再生能源市场的社会资本投资呈现显著抑制作用。关于可再生能源政策影响社会资本绿色投资途径的研究发现，可再生能源政策的作用主要体现为促进一国开拓可再生能源市场，但对可再生能源技术创新的促进效应暂未显现。

相较于既有研究，本文的创新和边际贡献主要体现在对社会资本参与绿色丝绸之路建设进行的深入探讨：①现有文献对“一带一路”绿色发展的研究主要集中在“一带一路”为沿线国家带来的环境改善效应（曹翔等，2020）和对中国绿色全要素生产率的提升作用（刘钻扩、辛丽，2018），以及如何利用对外直接投资推动“一带一路”绿色发展，但大多没有考虑社会资本在弥补可再生能源资金缺口中发挥的重要作用，本文从社会资本绿色投资的视角探索这一问题，弥补了现有文献研究的不足。②绿色丝绸之路的建设需要中国与沿线各国共商共建共享，研究东道国可再生能源政策对社会资本绿色投资积极性的影响有助于东道国从顶层政策设计视角改善当地投资环境，提高社会资本绿色投资意愿，对填补绿色丝绸之路建设资金缺口具有一定的参考价值。而且区别于已有研究仅聚焦于少数国家，本文的样本范围涵盖“一带一路”沿线45个处于不同经济发展水平和可再生能源发展阶段的国家，能够更精准地分析可再生能源政策对社会资本投资的影响。③在量化研究上，本文首次依据国家可再生能源市场发展阶段来探索可再生能源政策有效性，而非单纯讨论可再生能源政策在不同经济水平国家发挥的作用差异。虽然“一带一路”沿线国家大多为发展中国家，但部分国家的可再生能源市场因为可再生能源禀赋等原因较多数发达国家更为成熟，这说明“一带一路”沿线国家可再生能源市场发展与其经济水平之间可能并没有简单的对应关系，因此不区分发展阶段对可再生能源政策有效性的讨论与实际不符，而本文的研究对进一步提高可再生能源政策的针对性具有重要的政策参考意义。

文章其余部分的内容安排如下：第二部分为文献综述与研究假设；第三部分为模型构建与数据说明；第四部分为实证研究；第五部分为本文的结论与启示。

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二、文献综述与研究假设

本节从可再生能源政策、“一带一路”倡议与绿色投资、社会资本参与“一带一路”建设的角度梳理现有国内外研究，从可再生能源政策作用、政策与融资市场的阶段性演化和政策的可能作用途径等三个角度进行理论剖析，并据此提出本文的三个研究假设。

（一）文献综述

各国相继在政策引导上发力，通过出台上网电价补贴（FiT）、可再生能源长期战略规划等政策来鼓励开展可再生能源投资与合作，学界也开始关注可再生能源政策对清洁能源市场的影响。从可再生能源激励政策的角度来看，最初的研究大多基于理论分析和案例研究（Berry & Jaccard, 2001; Gan et al., 2007; Zarnikau, 2011），随后有学者使用计量经济学模型分析可再生能源政策的有效性。研究总体发现，可再生能源激励政策能有效提高可再生能源装机总量和使用比例（吴力波等，2015；Zhao et al., 2013），并促进企业加大绿色技术创新力度（张琦等，2019）。部分学者将可再生能源政策进行具体分类，发现绿色能源组合标准（RPS）和上网电价补贴（FiT）政策在所有可再生能源政策工具中吸引私人资本投资的有效性最为显著（Friedemann et al., 2015），其中RPS政策在欧洲市场的应用效果比FiT政策更佳（Dong, 2012），但RPS政策的设计缺陷导致其在美国能源市场应用存在一定局限性（Carley, 2009）。部分学者从可再生能源细分市场进行研究，发现政策的不确定性会降低开发商对美国光伏市场的投资积极性（Tsvetanov, 2019），政策的不连续性也会导致美国风电市场的投资波动（Barradale, 2010）。随着发展中国家对可再生能源市场的逐渐重视，少数学者也开始将研究视角转向经济相对落后的国家和地区。Kersey等（2021）对可再生能源政策在加勒比岛的实施效果进行研究，发现净计量电价政策对可再生能源装机总量的提升作用最为明显。Zhao等（2013）根据国家经济实力进行的分类研究发现，可再生能源政策对清洁能源装机容量的促进作用仅体现在发达国家和新兴经济体。遗憾的是，上述研究范围多数针对单一国家或少量国家，实证结果对发展中国家尤其是“一带一路”沿线国家不具有普遍性，且研究大多聚焦于单一可再生能源政策，并未探究东道国整体可再生能源政策环境对投资拉动的影响。此外，现有研究仅从国家经济状况着手进行可再生能源政策有效性的异质性分析，但几乎忽略了当地可再生能源市场发展状况对政策有效性的影响。基于此，本文在扩大样本研究范围的基础上，特别关注处于不同可再生能源市场发展阶段的国家，其可再生能源支持政策对社会资本投资的影响。

在全球低碳可持续发展的大背景下，绿色逐渐成为新时期“一带一路”倡议发展的鲜明主题，学界也涌现出不少相关领域的研究。现有文献验证了“一带一路”倡议为东道国和母国带来的福祉，包括东道国环境质量的改善（曹翔等，2020）和产业转型升级（张金珠等，2021），以及中国绿色全要素生产率的提高和企业绿色转型升级（刘钻扩、辛丽，2018；杨波、李波，2021）。为了进一步推动“一带

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一路”绿色发展，部分学者从环境法规体系建设和清洁能源外交战略定位等视角分析如何推动绿色丝绸之路的建设（李昕蕾，2020；孙佑海，2017），从而充分发挥绿色丝绸之路倡议的重要作用；部分学者从对外直接投资的角度分析中国对外直接绿色投资的投资潜力和主要影响因素，并验证了“一带一路”倡议对中国对外直接绿色投资规模的促进作用（Cheng & Qi, 2021; Liu et al., 2020）；也有学者使用TODIM方法评估“一带一路”沿线国家可再生能源投资风险（Hashemizadeh et al., 2021）。随着社会资本参与“一带一路”建设的热情见涨，学界也开始分析如何在“一带一路”建设中发挥社会资本的作用。部分学者从如何提高社会资本与政府合作的基建项目的成功率入手，发现东道国项目运作经验（罗煜等，2017）、东道国产业集聚度（贺炎林等，2021）、私人部门风险承担比例（罗煜等，2017）、项目融资方式（Patricia & Francesca , 2010）等因素对项目成功与否至关重要；部分学者从社会资本的参与方式、项目成本、东道国制度环境、国际金融机构的支持等方面探讨如何提高社会资本在“一带一路”沿线国家基建项目的投资规模（仇娟东等，2021；邓忠奇、陈甬军，2018；徐哲潇、杜国臣，2018）。值得注意的是，现有文献对社会资本参与“一带一路”沿线国家可再生能源投资的关注度不高，而且社会资本的逐利动机导致其对东道国可再生能源补贴等政策敏感性较高，但现有研究却大多忽视了“一带一路”沿线国家可再生能源政策对社会资本投资规模的影响。鉴于此，本文拟通过实证研究分析东道国可再生能源相关政策如何影响社会资本绿色投资规模，希望实证结果可以对相关研究进行有益的补充。

（二）研究假设

国际社会普遍认为可再生能源是实现全球能源转型的共同选择，各国需要根据市场主体特征进行有效的制度激励，利用市场化的手段加速可再生能源的发展。目前应用于可再生能源市场的公共政策类型多样，参考现有文献（Kersey et al., 2021; Polzin et al., 2019）、国际能源署（IEA）和国际可再生能源署（IRENA）关于可再生能源政策的整理，本文将当前“一带一路”沿线国家常用的可再生能源政策分为宏观政策、经济补贴政策、市场型政策、电网支持政策四类，具体包含的政策内容及定义见表1。

为了加速碳中和进程并构建清洁、低碳、安全、高效的能源体系，一方面，“一带一路”沿线国家在近年相继出台了以可再生能源长期战略规划为代表的宏观政策，该类政策着眼于国家能源市场的长远发展，通常包含一国在十年内需达成的可再生能源市场装机容量、碳排放目标等，类似政策的出台既明确了东道国未来一定时期的发展目标，也反映了东道国政府大力发展可再生能源的决心。另一方面，以税收优惠、上网电价补贴为代表的经济补贴政策也广泛应用于多数“一带一路”沿线国家的可再生能源市场。社会资本对可再生能源投资时主要关注项目的投资收益，而“一带一路”沿线国家的发展水平较为落后，电力需求弹性更大，因此可再生能源项目更依赖公共补贴政策来保障项目获得稳定的收益（Maianne et al., 2021），地方政府给予的公共补助可以有效降低社会资本参

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表1: 可再生能源政策总结

类别	政策名称	定义
宏观政策	可再生能源长期战略规划	国家发布战略性规划文件以明确未来一段时间内国家可再生能源发展目标，如可再生能源在国家能源结构中的占比、可再生能源装机容量等
经济补贴政策	直接财政补贴	政府为从事可再生能源行业开发、投资、运营的企业给予一定的资金支持
	税收优惠	通过减免应税税额或增值税抵扣的方式为可再生能源项目提供税收优惠
	上网电价补贴(FiT)	国家通过补贴可再生能源发电成本与传统上网电价的差额，保证运营成本较高的可再生能源项目能获得长期稳定的收益
市场型政策	可再生能源竞标拍卖	国家电力部门向所有具备条件的可再生能源开发商进行公开招标，通过市场竞争的方式锁定电价和发电量
电网支持政策	强制上网政策	电网企业在保证电网安全运行的前提下，对可再生能源发电提供无歧视甚至优先上网的服务，将可再生能源发电及时接入电网和并网运行
	电网基础设施支持政策	向电网基础设施配套设施建设提供资金支持，或者放开对输配电网投资主体的限制

与的项目投资风险，并激励企业和社会资本进行绿色技术创新(张琦等，2019)。

同时，随着可再生能源规模化发展和技术进步，清洁能源发电成本与煤电、天然气等传统发电成本的差距正不断缩小，可再生能源市场在某些发达国家或技术成熟的光伏、风电领域正逐步从补贴依赖发展为市场化竞争，因此，以可再生能源竞标拍卖和绩效奖补政策为代表的市场型激励政策也开始受到部分沿线国家的青睐。截至2018年底已有106个国家采用竞标拍卖的方式采购可再生能源电力(International Renewable Energy Agency, 2019)。以菲律宾绿色能源竞标机制为例，国家电力部门会在每轮竞标前发布封顶指导电价，投标者在标书中明确发电量和单位电价，边际成本最低者中标并与当地配售电公司签署长期购电协议(PPA)。可再生能源竞标采购政策有助于通过市场公开竞争方式降低清洁能源发电成本，同时通过签署长期购电协议的方式降低可再生能源开发商的投资风险，推动国家可再生能源发展进程。据此，本文提出假设1：

假设1：东道国可再生能源政策会促进社会资本在“一带一路”沿线国家进行绿色投资。

由于各国经济实力和可再生能源储量等存在差异，“一带一路”沿线国家处于不同的可再生能源发展阶段。对于可再生能源发展阶段的划分，Bird等(2005)选择可再生能源发电总量作为划分依据，Marques等(2010)依据可再生能源在一国能源供应总量的占比进行分类，马丽梅和黄崇乐(2022)和Romano等(2017)则选择了可再生能源发电量占总发电量的比例进行分类。本文选择可再生能源发电量占总发电量的比例作为可再生能源发展阶段的划分依据，将“一带一路”沿线国家的研究样本分为起步期(占比为0%~30%)和成长成熟期(占比＞30%)。可再生能源发展初期一般主要表现为技术创新投入及市场开拓(Surana & Anadon, 2015)，此时针对可再生能源的市场机制有

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待完善，且可再生能源发电成本相较于传统能源更高，消费者不愿意也无法承担如此高昂的购电价格，面对市场失灵与可再生能源市场资金缺口的双重困境，东道国政府支持可再生能源的政策将是推动能源转型的主要动力之一（范英、衣博文，2021）。随着技术成熟和可再生能源规模的不断扩大，可再生能源市场进入成长成熟期后，清洁能源发电成本与传统能源发电成本的差异逐步缩小，因此政府的政策支持力度会有所降低，可再生能源发展将逐步由政策驱动型转变为市场驱动型（International Energy Agency, 2016），政府需要激发市场主体活力来推动可再生能源的进一步发展，其中融资市场将发挥重要作用，原因在于：①可再生能源项目属于投资规模大且投资回报周期长的重资产领域，因此社会资本往往需要通过长期融资的方式降低自身资金压力（Kim & Park, 2016; Maianne et al., 2021）。②随着可再生能源市场规模的不断扩大，可再生能源开发商的资金需求将直线上升，而金融市场健全的市场机制可以充分发挥市场在资源配置中的决定性作用，通过提供股权融资、降低融资成本等方式来降低社会资本的资金压力（Egli et al., 2019; Ji & Zhang, 2019; Shahbaz et al., 2013）。③可再生能源市场进入成长成熟期后，项目竞争加剧，各个可再生能源开发商之间的建设成本差异会随着市场整体技术成熟度的提升而不断缩小，此时项目融资成本的高低是决定社会资本竞争报价能力和保障可观投资回报率的重要因素。因此金融市场将成为可再生能源市场成长成熟期的主要驱动力。据此，本文提出假设2：

假设2：在可再生能源发展起步期，东道国可再生能源政策是吸引社会资本绿色投资的主要驱动力；在可再生能源发展成长成熟期，以融资市场为代表的市场化机制将对社会资本产生显著的正向驱动作用。

可再生能源政策对社会资本绿色投资的影响途径可能有两个：第一是促进市场开拓。可再生能源发展初期的开发成本高、投资风险大，公众也可能因为环境保护意识欠缺和高昂的清洁能源发电成本而对可再生能源的接受程度较低（Almulhim, 2022），因此可再生能源在与传统能源的竞争中处于劣势，此时各国政府采取的一系列政策措施将对可再生能源市场的开发起到重要的支持作用。一方面，《国家能源政策法》和《国家可再生能源发展战略规划》等宏观框架性政策把可再生能源提到与传统能源同等重要的地位，表明国家大力发展可再生能源的决心（Terrados et al., 2007），可再生能源市场进入正式开拓阶段。另一方面，经济补贴、税收减免和低息贷款等直接经济支持政策能显著降低社会资本的清洁能源开发成本（Özdemir et al., 2020），更多社会资本在政策红利的吸引下迈入可再生能源市场进行项目投资，可再生能源市场得到进一步扩大。第二是推动技术革新。技术革新对降低清洁能源开发成本、提高能源效率和加快能源转型具有重要意义，各国的政策环境也可能成为技术革新的主要驱动力。一方面，以碳排放权交易为代表的市场化政策会通过提高化石能源电价的方式使可再生能源相对于传统化石能源具有更强的竞争优势，激励市场主体投资于可再生能源上、中、下游的全产业链，从而进一步促进可再生能源的技术进步（齐绍洲、张振源，2019），

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同时还可以通过内部化环境成本、降低技术开发风险等方式促进低碳技术创新(Cong & Wei, 2010; Friedemann et al., 2015; Rogge & Hoffmann, 2010)。另一方面,为了鼓励可再生能源的快速发展,多国用于清洁能源技术研发的投资预算逐年增加,某些国家从碳市场配额拍卖机制中获得的拍卖收入也会有部分用于可再生能源项目研发(齐绍洲等,2018)。据此,本文提出假设3a和3b:

假设3a:可再生能源政策会促进一国开拓可再生能源市场。

假设3b:可再生能源政策会推动一国可再生能源技术革新。

三、模型构建与数据说明

东道国可再生能源政策对社会资本绿色投资行为的影响主要体现在两个阶段,第一阶段是社会资本决定是否投资于可再生能源领域,第二阶段是社会资本对可再生能源项目的投资规模。因此,本文构建两个模型全面考察东道国可再生能源政策与社会资本在"一带一路"沿线国家绿色投资行为的关系,并对本文实证研究的数据来源加以说明。

(一)模型构建

1.模型一:东道国可再生能源政策对社会资本绿色决策的影响

本文参考罗煜等(2017)的做法,构建标准Probit模型考察东道国可再生能源政策对社会资本绿色决策的影响,具体表示为:

$$Pr(Green=1)=\Phi(\alpha_0+\alpha_1\times Policy_{it}+\alpha_2\times Control_1+\varphi_t+\gamma_c+\varepsilon) \quad (1)$$

其中,*Green*是社会资本绿色投资决策的二元选择变量,社会资本若投资于可再生能源项目,取值为1,否则为0。本文的可再生能源项目包括以太阳能、水能、风能、生物质能、地热能、沼气为主要能源的投资项目。核心解释变量*Policy*表示*i*国在*t*年可再生能源市场政策力度。本基准模型同时纳入项目特征变量和东道国特征变量作为控制变量($Control_1$),其中项目特征变量包括可再生能源项目装机容量(*Capacity*)、是否获得多边金融机构支持(*Multi*)、项目风险结构(*Risk*);东道国特征变量选用东道国的年均GDP(ln*GDP*,经过对数变换)和GDP增速(*GDPgrowth*)以控制东道国的经济发展水平对社会资本绿色决策的影响。此外,通过加入年份固定效应φ_t和地区固定效应γ_c尽可能地控制不可观测因素对回归结果的影响。ε为随机扰动项。

2.模型二:东道国可再生能源政策对社会资本可再生能源投资规模的影响

$$\ln Investment=\beta_0+\beta_1\times Policy_{it}+\beta_2\times FinFreedom_{it}+\beta_3\times Control_2+\theta_t+\sigma_c+\mu \quad (2)$$

模型二的被解释变量ln*Investment*表示社会资本对可再生能源项目的投资规模(经过对数变换),核心解释变量*Policy*含义同模型一,解释变量*FinFreedom*表示*i*国*t*年的融资自由度。$Control_2$包括项目层面和东道国层面的两类控制变量,其中项目层面变量包括可再生能源项目装机容量

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(*Capacity*)和是否获得多边金融机构支持(*Multi*),东道国层面变量在模型一基础上增加东道国政府治理能力变量,具体使用腐败控制能力(*AntiCorrupt*)、民众话语权(*Voice*)、政局稳定性(*Stability*)等三个指标表示。模型二也通过加入时间固定效应θ_t和国家固定效应σ_c以控制不可观测因素对回归结果的影响,μ为随机扰动项。

(二)数据说明

本文的研究样本来自世界银行PPI数据库,该数据库提供了1990~2020年社会资本在全球127个中低收入国家参与的10421个基础设施(Private Participation in Infrastructure,简称PPI)投资项目,是目前可以得到的关于社会资本在发展中国家基础设施投资样本量最大、权威性最强的数据资料(罗煜等,2017),涵盖了能源、交通、水利、信息通讯技术等主要基础设施领域。本文以PPI数据库中有数据收录的45个"一带一路"沿线国家2010~2019年的能源投资项目作为研究对象(详见表2),并选取以下四个项目信息作为主要数据:第一,项目能源属性。PPI数据库中收集的社会资本在"一带一路"

表2: 研究对象地区分布及收入水平分组

国家	地区	收入水平	国家	地区	收入水平
阿尔及利亚	中东北非	中高	印度尼西亚	东亚	中低
伊朗	中东北非	中高	秘鲁	拉丁美洲和加勒比地区	中高
摩洛哥	中东北非	中低	牙买加	拉丁美洲和加勒比地区	中高
埃及	中东北非	中低	哥斯达黎加	拉丁美洲和加勒比地区	中高
塞尔维亚	欧洲及中亚	中高	多米尼加共和国	拉丁美洲和加勒比地区	中高
土耳其	欧洲及中亚	中高	厄瓜多尔	拉丁美洲和加勒比地区	中高
俄罗斯	欧洲及中亚	中高	安哥拉	撒哈拉以南非洲	中低
罗马尼亚	欧洲及中亚	中高	南非	撒哈拉以南非洲	中高
保加利亚	欧洲及中亚	中高	肯尼亚	撒哈拉以南非洲	中低
哈萨克斯坦	欧洲及中亚	中高	喀麦隆	撒哈拉以南非洲	中低
乌克兰	欧洲及中亚	中低	赞比亚	撒哈拉以南非洲	中低
斯里兰卡	南亚	中高	科特迪瓦	撒哈拉以南非洲	中低
泰国	南亚	中高	尼日利亚	撒哈拉以南非洲	中低
越南	南亚	中低	塞内加尔	撒哈拉以南非洲	中低
巴基斯坦	南亚	中低	津巴布韦	撒哈拉以南非洲	中低
孟加拉国	南亚	低	马里	撒哈拉以南非洲	低
尼泊尔	南亚	低	莫桑比克	撒哈拉以南非洲	低
马来西亚	东亚	中高	塞拉利昂	撒哈拉以南非洲	低
中国	东亚	中高	埃塞俄比亚	撒哈拉以南非洲	低
柬埔寨	东亚	中低	乍得	撒哈拉以南非洲	低
老挝	东亚	中低	卢旺达	撒哈拉以南非洲	低
蒙古	东亚	中低	乌干达	撒哈拉以南非洲	低
菲律宾	东亚	中低			

资料来源:世界银行PPI数据库。

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沿线国家参加的能源项目可分为不可再生能源项目和可再生能源项目，其中不可再生能源项目包括石油、天然气、煤电项目，可再生能源项目包括太阳能、水能、风能、生物质能、地热能、沼气项目。第二，社会资本对可再生能源项目的投资规模。第三，项目落地年份。项目落地年份即为项目完成融资日所处年份，该日期意味着政府与社会资本就风险承担、权责分配、融资方案等核心事项达成了具有法律约束效力的合同，项目正式落地。第四，项目装机容量。项目装机容量可以反映项目的规模。装机容量越大的项目意味着越高的投资需求。

本文的核心解释变量*Policy*来自世界银行可持续能源监管指标数据库（RISE）。RISE数据库通过构建各国在电力供应、环保烹饪、能源效率和可再生能源等四个领域的政策支持框架指标来评估全球138个国家可持续能源投资环境，其中针对可再生能源领域构建了可再生能源法律框架（*Legal*）、长期战略规划（*Plan*）、补贴支持政策（*Incentives*）、竞标拍卖政策（*Auction*）、上网支持政策（*Connection*）、融资支持政策（*Finance*）、碳定价（*Carbon*）等7个子指标。通过对一国可再生能源市场政策子指标设置一系列封闭式问题（即答案为是或否），并根据从业人员或专家给出的答案为问题对应的子指标赋值，最终将各子指标分数进行加权平均获得变量数据。该数值越大，说明该国可再生能源市场政策力度越强。模型二的解释变量融资自由度（*FinFreedom*）来自美国传统基金会数据库，该变量用于衡量在一国银行的融资效率和金融机构不受国家政府控制和干预的程度。当政府对金融机构的干预仅限于基本的业务监管和预防欺诈时，金融机构可以相对自由地根据市场化条件为个人和公司提供信贷、存款、外币等业务，因此该指标数值越大，意味着一国融资市场可以更好地发挥其市场化调节资源配置的作用。

控制变量中的东道国政府治理能力变量来自世界银行全球治理指标数据库（WGI），东道国经济增速（*GDPgrowth*）和经济规模（*lnGDP*）变量来自世界银行数据库。基于以上选择，本文模型一的研究样本范围为1293个能源投资项目，模型二的研究样本范围为1010个可再生能源投资项目，使用的变量描述性统计如表3和表4所示。

表3：模型一变量描述性统计表

变量名称	观察值	平均值	标准差	最小值	最大值
Green	1293	0.830	0.376	0.000	1.000
Policy	1293	40.420	19.700	1.000	86.000
Multi	1293	0.193	0.395	0.000	1.000
Risk	1254	7.736	1.183	2.000	12.000
Capacity	1293	230.300	879.800	0.500	12900.000
GDPgrowth	1293	5.454	2.681	-4.387	12.320
ln*GDP*	1293	6.182	1.940	1.079	9.571

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表4: 模型二变量描述性统计表

变量名称	观察值	平均值	标准差	最小值	最大值
ln*Investment*	1010	4.178	1.203	0.148	7.601
Policy	1010	41.910	20.230	2.000	86.000
FinFreedom	1010	42.510	14.110	10.000	70.000
Multi	1010	0.198	0.399	0.000	1.000
Capacity	1010	65.020	102.500	0.500	1360.000
AntiCorrupt	1010	-0.396	0.327	-1.421	0.762
Voice	1010	-0.688	0.806	-1.802	1.152
Stability	1010	-0.625	0.660	-2.810	0.841
GDPgrowth	1010	5.481	2.767	-1.590	12.320
ln*GDP*	1010	6.365	2.022	1.079	9.571

四、实证研究

在前文理论分析的基础上，本节首先进行基准模型回归以揭示可再生能源政策与社会资本投资决策的关系。随后，本节进行稳健性检验和异质性分析来探讨基准结果的稳健性和结果在不同样本中的差异，并进一步构建两个双向固定效应模型来深入研究东道国可再生能源政策影响社会资本绿色投资规模的可能途径。

（一）基准模型回归

本节主要通过上一节构建的两个基准模型来验证东道国可再生能源政策与社会资本的关联。

模型一：东道国可再生能源政策对社会资本绿色决策的影响

本文使用标准Probit模型作为模型一，以社会资本绿色投资决策的二元选择变量作为被解释变量，以东道国可再生能源市场政策力度作为解释变量，通过引入项目特征变量和东道国特征变量等控制变量来考察东道国可再生能源政策对社会资本绿色决策的影响。

表5显示东道国可再生能源政策对社会资本绿色投资决策影响的基础回归结果，其中第(1)列为加入影响社会资本绿色投资决策的解释变量后的回归结果，(2)(3)列分别加入了时间虚拟变量和地区虚拟变量，(4)列为同时控制时间虚拟变量和地区虚拟变量的回归结果。回归结果表明，一国可再生能源支持政策对社会资本作出可再生能源投资的决策具有显著正向影响，这验证了可再生能源政策环境对社会资本作出绿色投资决策的积极作用，而项目规模和社会资本承担的项目风险与社会资本的绿色投资决策呈现显著负向关系，即项目规模越大、社会资本承担的项目风险越高，社会资本越不愿意作出绿色投资决策，这说明社会资本目前对于“一带一路”沿线的可再生能源项

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表5: 模型一基准回归结果

变量名称	(1)	(2)	(3)	(4)
	Green	*Green*	*Green*	*Green*
Policy	0.0028***	0.0025***	0.0022***	0.0013**
	(0.0005)	(0.0006)	(0.0005)	(0.0007)
Multi	-0.0049	-0.0093	0.0029	-0.0059
	(0.0179)	(0.0181)	(0.0182)	(0.0182)
Risk	-0.0471***	-0.0435***	-0.0470***	-0.0406***
	(0.0066)	(0.0067)	(0.0066)	(0.0067)
Capacity	-0.0005***	-0.0005***	-0.0005***	-0.0005***
	0.0000	0.0000	0.0000	0.0000
GDPgrowth	0.0018	0.0022	-0.0005	0.0011
	(0.0032)	(0.0032)	(0.0033)	(0.0034)
ln*GDP*	0.0235***	0.0244***	0.0141***	0.0125**
	(0.0047)	(0.0047)	(0.0050)	(0.0051)
时间虚拟变量		是		是
地区虚拟变量			是	是
观测值	1 293	1 293	1 293	1 293

注：表内报告的是估计结果的边际效应，括号中的数字是标准差，***、**和*分别表示1%、5%和10%显著性水平，余下同。

目仍处于投资试水期，这可能是因为“一带一路”沿线国家的可再生能源市场技术欠发达且投资成本较高，投资风险仍然较大，因此社会资本不敢贸然接手规模较大的可再生能源投资项目。

模型二：东道国可再生能源政策对社会资本可再生能源投资规模的影响

模型二选取社会资本在“一带一路”沿线国家参与的可再生能源项目为研究对象，以社会资本参与的可再生能源项目投资规模为被解释变量，在模型一解释变量的基础上增加东道国融资自由度作为另一核心解释变量，探讨东道国可再生能源政策对社会资本可再生能源投资规模的影响。

表6的第(1)列为加入影响社会资本绿色投资规模的解释变量后的回归结果，(2)(3)列分别加入了时间虚拟变量和国家虚拟变量，(4)列为同时控制时间虚拟变量和国家虚拟变量的回归结果。进一步分析东道国可再生能源政策与社会资本绿色投资规模的关系。表6的回归结果显示，核心变量东道国可再生能源政策会显著提高社会资本的绿色投资规模，且融资市场自由度越高，社会资本对可再生能源项目的投资规模越大，这是因为可再生能源属于重资产行业，在建设初期所需固定资产投资规模很大，且运营期的资金成本占比也很大，因此融资市场对可再生能源项目投资非常重要。其他控制变量的回归结果表明，一方面，国际金融机构的参加能提高社会资本的绿色投资意愿，这是因为可再生能源项目属于公共属性极强的外部性产品，多数由东道国政府发起，因此政府在可再生能源项目的定价、经营方式和收益来源等核心条款谈判中掌握主要的话语权，且在公共利益与社会资本的逐利目的相冲突时，往往选择牺牲社会资本以保证项目的公共品属性，因此社会资本在与政府合作的基建项目博弈中常处于劣势地位(龚强等，2019)。由多个成员国组成的政府间性质的

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表6: 模型二基准回归结果

变量名称	(1)	(2)	(3)	(4)
	ln*Investment*	ln*Investment*	ln*Investment*	ln*Investment*
Policy	-0.0007	-0.0013	0.0057*	0.0088**
	(0.0017)	(0.0023)	(0.0030)	(0.0041)
FinFreedom	0.0049	0.0047	0.0198**	0.0210**
	(0.0033)	(0.0033)	(0.0086)	(0.0094)
Multi	0.5680***	0.5660***	0.4600***	0.4630***
	(0.0810)	(0.0798)	(0.0852)	(0.0860)
Capacity	0.0072***	0.0071***	0.0064***	0.0064***
	(0.0011)	(0.0011)	(0.0010)	(0.0010)
AntiCorrupt	-0.1520	-0.1770	0.2430	0.1520
	(0.1300)	(0.1340)	(0.4330)	(0.4640)
Voice	0.2360***	0.2460***	-0.2040	-0.1630
	(0.0644)	(0.0652)	(0.2970)	(0.3070)
Stability	0.1400***	0.1430***	0.5310***	0.554***
	(0.0519)	(0.0526)	(0.1920)	(0.2080)
GDPgrowth	-0.0317*	-0.0201	0.0287	0.0308
	(0.0183)	(0.0197)	(0.0229)	(0.0244)
ln*GDP*	0.1470***	0.1360***	-0.3880	-0.2240
	(0.0267)	(0.0276)	(0.3420)	(0.4350)
时间虚拟变量		是		是
国家虚拟变量			是	是
观测值	1010	1010	1010	1010

注:括号中的数字是标准差。

国际金融机构通常汇集了不同国家的主权财富资金,在基建项目的磋商过程中往往代表出资国或社会资本与东道国政府谈判(罗煜等,2017)。国际金融机构利用其丰富的基建项目融资经验和强大的全球影响力,增强社会资本方的谈判主动权,并根据项目特征制定合理的融资方案,更有能力降低社会资本参与项目的政治、金融、运营等风险,从而提高社会资本的可再生能源项目投资规模。另一方面,东道国的政局稳定性也会对社会资本投资规模产生正向影响。“一带一路”沿线的部分国家和地区武装冲突频繁发生,地缘政治风险突出,政局形势持续动荡(World Economic Forum, 2022),执政党的频繁更迭可能会导致国家可再生能源政策和针对项目提供的意向性担保等内容的反复调整,新任政府毁约的情况也可能会发生,因此社会资本更愿意投资于政局稳定的“一带一路”沿线国家。以上结果说明东道国可再生能源政策对吸引社会资本绿色投资具有显著促进作用。综上所述,假设1得到验证。

(二)进一步分析

1.稳健性检验

(1)剔除特殊国家

考虑到样本中涉及社会资本在中国参与的能源和可再生能源项目数量占比分别为21.7%(281

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个项目)和27.5%(275个项目),可能会使回归结果有偏,且本研究更希望探讨“一带一路”沿线国家可再生能源政策环境对社会资本绿色投资的影响,以便帮助沿线国家解决绿色资金缺口问题。因此,本部分从总研究样本中剔除中国样本来考察东道国可再生能源政策对社会资本绿色投资的影响,并对模型一、二进行重新回归。表7第(1)(2)列回归结果与基准检验结果一致,验证了基准检验的稳健性。

(2)更换被解释变量

模型二的基准检验选取社会资本对可再生能源项目的总投资规模作为被解释变量,该数据不仅包含社会资本对实物资产的投资额,还涵盖了社会资本为获取项目开发权而支付的特许经营权费。考虑到实物资产投资额更能代表项目的资金需求,且东道国政府吸引社会资本参与可再生能源项目的初衷是利用社会资本在投资、建设、运营方面的综合实力来提高当地的可再生能源装机容量,而不是通过转移项目经营开发权的方式单纯改善当地可再生能源项目运营状况,因此本文进一步选取社会资本对可再生能源项目的实物投资额(ln*Phyinvest*)代替原被解释变量,运用与基准检验相同的方法进行回归分析,表7第(3)列的结果验证了基准检验结果的稳健性。

(3)考虑东道国GDP滞后项

考虑到模型二控制变量中东道国GDP与被解释变量可再生能源投资规模之间可能存在互为因果的关系,且东道国GDP对社会资本绿色投资规模的影响可能存在一定滞后,因此本文在基准模型中进一步加入东道国GDP滞后一期的变量以检验基准回归的稳健性,结果如表7第(4)列所示。回归结果与基准检验结果一致,同样验证了基准检验的稳健性。

表7: 稳健性检验

变量名称	(1)	(2)	(3)	(4)
	Green	ln*Investment*	ln*Phyinvest*	ln*Investment*
Policy	0.0019**	0.0149**	0.0090**	0.0104**
	(0.0008)	(0.0070)	(0.0040)	(0.0044)
控制变量	是	是	是	是
观测值	978	735	988	1010

2.异质性分析

(1)可再生能源发展阶段

本部分在模型二基准检验的基础上,进一步分析可再生能源政策在不同可再生能源发展阶段发挥的作用,回归结果见表8。表8第(1)(2)列结果显示,当一国可再生能源市场处于起步期时,国家出台的可再生能源政策对社会资本绿色投资具有显著吸引作用,而处于成长成熟期的可再生能源市场的政策因素促进作用将不再显著,此时融资市场开始发挥显著正向作用。据此,假设2得到验证。

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表8: 区分可再生能源发展阶段的回归结果

变量名称	(1)	(2)
	起步期	成长成熟期
	ln*Investment*	ln*Investment*
Policy	0.0105*	0.0058
	(0.0054)	(0.0195)
FinFreedom	0.0089	0.1450***
	(0.0112)	(0.0399)
控制变量	是	是
观测值	774	193
Chow Policy	-0.0072***	
Chow Finfreedom	-0.0107***	

注:*Chow Policy*, *Chow FinFreedom*分别表示可再生能源市场政策力度和融资自由度回归系数的组间差异的Chow检验卡方值。

(2)可再生能源政策类别

模型二的基准检验结果说明东道国可再生能源政策对社会资本绿色投资的吸引力,本部分进一步选取RISE数据库提供的5个国家可再生能源政策子指标,即可再生能源长期战略规划(Plan)、可再生能源补贴政策(Incentives)、可再生能源竞标拍卖政策(Auction)、电力上网支持政策(Connection)、融资支持政策(Finance),对模型二重新回归以便分析各具体政策在吸引社会资本中发挥的作用,回归结果如表9第(1)列所示。回归结果表明,可再生能源长期战略规划的存在有助于提高社会资本的可再生能源投资规模。由于可再生能源长期战略规划的出台可以在一定程度上表明东道国政府发展可再生能源市场的决心,这可能进一步体现在政府经济支持力度的增大等方面,因此对社会资本具有显著吸引力。

表9的第(2)(3)列对可再生能源具体政策在不同可再生能源发展阶段的绿色投资吸引效果作进一步分析,研究发现可再生能源长期战略规划对处于各个阶段的可再生能源市场均具有社会资本吸引作用,而可再生能源竞标拍卖政策对处于起步期的可再生能源市场投资呈现显著抑制作用,这是因为可再生能源竞标拍卖政策属于市场化政策,目的是通过市场公开竞争方式降低清洁能源发电成本,而对于仍然严重依赖补贴的处于起步期的可再生能源市场而言,这种市场竞争往往会对项目现金流产生严重负面影响,从而抑制社会资本的绿色投资意愿。

3.政策的可能影响途径

本文的基准检验部分验证了可再生能源政策对社会资本绿色投资的显著吸引力,本部分进一步研究政策的具体作用机制。

(1)可再生能源政策与市场开拓

本文构建时间、国家双向固定效应模型对此进行研究,具体模型设定如下。本文采用可再生能

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表9: 区分可再生能源政策类别的回归结果

变量名称	(1)	(2)	(3)
	全样本	起步期	成长成熟期
	ln*Investment*	ln*Investment*	ln*Investment*
Plan	0.0150***	0.0171**	0.0188*
	(0.0050)	(0.0080)	(0.0104)
Incentives	-0.0068	-0.0125	-0.0073
	(0.0052)	(0.0087)	(0.0153)
Auction	-0.0154	-0.0515***	-0.1120
	(0.0168)	(0.0230)	(0.1460)
Finance	0.0046	0.0107	-0.0014
	(0.0055)	(0.0081)	(0.0148)
Connection	-0.0101	0.0356	-0.0643
	(0.0166)	(0.0243)	(0.0708)
FinFreedom	0.0271***	0.0184	0.0733
	(0.0093)	(0.0124)	(0.0563)
控制变量	是	是	是
观测值	1010	774	193
Chow Plan		-0.0084***	
Chow Incentives		-0.0096***	
Chow Auction		-0.0418***	
Chow Finance		-0.0084***	
Chow Connection		-0.0115***	
Chow FinFreedom		-0.0130***	

注：*Chow Plan, Chow Incentives, Chow Auction, Chow Finance, Chow Connection, Chow FinFreedom*分别表示可再生能源市场政策子指标和融资自由度回归系数的组间差异的Chow检验卡方值。

源装机总量(*GreenCapacity*)衡量一国可再生能源市场开拓情况，该数据来自国际可再生能源署(IRENA)数据库，由于数据库中涉及的“一带一路”国家数量有限，因此本部分仅选取了基准样本中的38个国家进行检验。控制变量($Control_3$)包括：①环境规制变量，采用i国t年环境规制严苛程度(*EnvStringency*)和环境规制执行力度(*EnvEnforcement*)两个指标，数据来自世界经济论坛发布的全球竞争力报告；②政府治理能力，采用i国t年腐败控制能力(*AntiCorrupt*)、政治稳定程度(*Stability*)和民众话语权(*Voice*)三个变量表示；③国家经济实力，采用经济规模(ln*GDP*，经过对数变换)和经济增速(*GDPgrowth*)两个变量表示。θ_t表示国家固定效应，σ_c表示时间固定效应，μ表示扰动项。

$$GreenCapacity_{it}=\beta_0+\beta_1\times Policy_{it}+\beta_2\times Control_3+\theta_t+\sigma_c+\mu \quad (3)$$

检验结果如表10第(1)列所示，结果表明可再生能源政策可以显著促进一国可再生能源市场的发展，假设3a得到验证。

(2)可再生能源政策与技术创新

本部分的具体模型设定如下，采用可再生能源绿色专利新增数量(*GreenPatent*)衡量一国可再生能源技术创新能力，数据来自国际可再生能源署(IRENA)数据库，该数据库中绿色专利变量覆

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盖的国家非常少，其中仅涉及14个国家近10年的完整数据，因此本部分以上述14个国家作为检验样本。此外，由于各国新增绿色专利数量差异较大，且有部分国家无年度新增绿色专利，因此本变量采用+1取对数形式以改进回归模型的拟合优度。控制变量（$Control_4$）包括：①环境规制变量，采用i国t年环境规制严苛程度（*EnvStringency*）和环境规制执行力度（*EnvEnforcement*）两个指标；②政府治理能力，采用i国t年腐败控制能力（*AntiCorrupt*）、政治稳定程度（*Stability*）和民众话语权（*Voice*）三个变量表示；③国家经济实力，采用经济规模（ln*GDP*，经过对数变换）和经济增速（*GDPgrowth*）两个变量表示。θ_t表示国家固定效应，σ_c表示时间固定效应，μ表示扰动项。

$$GreenPatent=\beta_0+\beta_1\times Policy_{it}+\beta_2\times Control_4+\theta_t+\sigma_c+\mu \quad (4)$$

表10第（2）列的检验结果并没有验证可再生能源政策对一国技术创新的促进或抑制作用，其中可能的原因有：一是因为“一带一路”沿线国家多数属于发展中国家或新兴经济体，经济实力的差异导致其科研技术水平落后于发达国家，这意味着在可再生能源市场发展初期，可再生能源技术主要依靠从其他发达国家引进而非自主研发（Kim, 2020），因此国家政策对技术创新的积极影响暂时无法显现；当发展进入成长成熟期后，国家政策可能才会逐渐对一国技术创新发挥作用。二是因为不具有技术创新针对性的可再生能源激励政策不一定能够引发可再生能源行业的技术革新，更具有针对性的技术创新激励政策、国家整体技术研发人才培养等整体环境的改善可能对技术创新更有益。

表10：可再生能源政策的可能影响途径

变量名称	（1）	（2）
	GreenCapacity	*GreenPatent*
Policy	1.019***	0.0106
	(0.210)	(0.0088)
控制变量	是	是
时间固定效应	是	是
国家固定效应	是	是
观测值	380	140

五、结论与启示

本文从社会资本参与绿色丝绸之路建设的角度出发，采用“一带一路”沿线45个国家2010~2019年的1293个社会资本参与的能源投资项目对东道国可再生能源政策吸引社会资本的有效性展开分析，希望可以为完善国家政策环境体系、解决“一带一路”沿线绿色资金缺口提供理论支撑和政策参考。研究结果表明，第一，国家可再生能源政策支持体系总体对社会资本具有显著吸引力，具体体现在作出绿色投资决策及增大绿色投资规模两方面。第二，区分可再生能源发展阶段的回归结果

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显示，可再生能源政策对社会资本绿色投资的吸引作用仅体现在处于起步期的可再生能源市场，而当一国可再生能源市场处于成长成熟期后，融资市场自由度成为社会资本绿色投资的主要驱动力，市场在资源配置中的决定性作用逐渐凸显。第三，对可再生能源政策体系进一步分类后发现，以可再生能源长期战略规划为代表的宏观政策对不同阶段的可再生能源市场均具有吸引社会资本的作用，而以可再生能源竞标拍卖政策为代表的市场激励型政策对处于起步期的可再生能源市场的社会资本投资呈现显著抑制作用。第四，可再生能源政策吸引社会资本的途径可能体现在促进可再生能源市场规模的扩大，但对可再生能源技术创新的促进作用暂未显现。“一带一路”沿线国家的可再生能源市场发展阶段有较大差异，一方面，多数国家的可再生能源市场仍处于起步阶段，因此构建更有效的政策体系对于深入推进能源转型至关重要。另一方面，国家能源局的数据显示，2021年中国可再生能源发电量占全社会用电量比例达到29.8%，可再生能源市场即将迈入成长成熟期，此时如何实现中国可再生能源政策与市场化改革的衔接也是重中之重。基于此，本文提出如下政策启示：

（1）优化国家可再生能源政策体系。一方面，要重点发挥可再生能源长期战略规划等宏观政策的战略导向作用，针对不同可再生能源技术市场的消纳情况和能源禀赋等情况，制定短期、中期和长期的合理战略发展目标和具体安排，为快速实现能源转型奠定扎实基础。另一方面，可以在光伏、风电等技术较成熟市场开展差价合约、溢价补贴机制、清洁能源竞标拍卖等市场化政策试点，进一步增强可再生能源的价格竞争力。

（2）注重政策支持体系与市场化机制的有效衔接，持续推进可再生能源市场发展。随着可再生能源发电成本的不断下降，政策支持力度的进一步下降和市场化程度的提高是可再生能源发展的必然趋势。在可再生能源市场由起步期向成长期过渡的历史性拐点阶段，首先，通过电力现货市场的公开竞争方式降低可再生能源发电边际成本，同时利用长期购电协议（PPA）和拍卖补贴等支持性政策实现从大规模政府补贴到市场竞价的逐步过渡。其次，通过完善绿色电力证书机制和增加可再生能源并网规模等手段，健全绿色能源消费机制，通过建立可再生能源电力消纳保障机制来提高电力市场消纳水平，促成可再生能源电力消纳责任向各类市场主体的合理分担。最后，虽然可再生能源是全球第三次能源转型的主要驱动力，但基于“一带一路”沿线国家的国情来看，还应注重可再生能源与煤电等传统能源的互补式发展关系，通过深化电力市场体制改革和完善电价市场化机制，实现能源市场的合理转型。

（3）充分发挥金融市场机制，拓宽可再生能源领域融资渠道。可再生能源项目涉及投资规模较大，社会资本等项目投资主体具有较高的资金需求，因此应重视金融市场的建设，积极推动绿色信贷的实施，进一步加大绿色债券、绿色信贷等绿色金融产品对符合条件可再生能源项目的支持力度；鼓励丝路基金、亚洲基础设施投资银行等国际金融机构落实《“一带一路”绿色投资原则》，进一

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步丰富政策性金融手段，通过债权、股权、股债结合和私募基金等方式直接或间接参与投资，通过积极探索以项目资产作为还款担保的项目融资以及与多边机构和商业银行的混合式融资等方式拓宽清洁能源融资渠道，缓解社会资本资金压力。

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Renewable Energy Policies and Private Capital Participation – A Study on Energy Investment Projects in BRI Countries

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Abstract: *This paper examines the effectiveness of renewable energy policies in catalyzing private green investment based on data of 1,293 energy investment projects from 45 BRI countries between 2010 and 2019. According to our empirical results, a country's renewable energy policies have a key influence in private capital decisions to make and scale up green investments. Regression results show that renewables policies encourage private green investments only when the renewables market is still in its infancy. When the market enters growth and maturity stages, however, financial markets will take the place of policy incentives as the primary force behind private green investments. While renewables policies help scale up private green investments by broadening the renewable energy market, it is yet unclear how such the policies promote renewable energy innovation. In order to advance green development under the Belt and Road Initiative (BRI), we should expand access to financing for the renewable energy industry in addition to improving the national renewable energy policy system.*

Keywords: *Belt and Road Initiative (BRI), renewable energy policy, private capital, green investment*

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1. Introduction

In 2013, President Xi Jinping introduced the Belt and Road Initiative (BRI) as an open platform that brings about opportunities and dynamism for international cooperation and development. Green development goals with carbon neutrality at the heart have become common aspirations for many countries, reflecting recent improvements in global environmental governance. According to the Energy and Climate Intelligence Unit (ECIU), 132 countries and regions around the world have adopted carbon neutrality goals, and China has promised to peak its carbon dioxide emissions by 2030 and achieve carbon neutrality by 2060. In the global context of low-carbon and sustainable development, green has become a conspicuous theme of the BRI for the new era. In May 2017, the then Ministry of Environmental Protection, Ministry of Foreign Affairs, National Development and Reform Commission

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(NDRC) and Ministry of Commerce jointly released the *Guidelines on Promoting Green BRI Development*, vowing to build a "Green Silk Road".

The promotion of sustainable development in BRI countries through green investment has become essential to the BRI's agenda in the new era, which focuses on infrastructure interconnectivity. Advanced infrastructures will facilitate regional exchanges and attract capital to spur economic growth. Yet infrastructure projects are capital-intensive and take time to build and recoup investment. Electric power and other energy projects, for instance, may damage local vegetation and create noise pollution during construction and emit large volumes of carbon dioxide during operation. At the Second Belt and Road Forum for International Cooperation, President Xi Jinping stressed that "The Belt and Road is not an exclusive club; it aims to promote green development. We may launch green infrastructure projects, make green investment, and provide green financing". In promoting the BRI's green development, it is vital to steer sustainable infrastructure development and increase the consumption of renewable energies.

Sluggish economic situation and shortage of funds have stymied renewable energy development in some BRI countries. According to the *Quantified Report on Green Investment and Carbon Emission Paths in BRI Countries*, it would take additional green investments worth at least 12 trillion US dollars between 2016 and 2030 for these countries to achieve the climate goals under the Paris Accord (Climate Works Foundation, 2019). Developing economies have faced fiscal deficits and pressures from deleveraging operations since the 2008 global financial crisis. To make things worse, the global economic recession due to COVID-19 fallout is challenging the fiscal systems of BRI countries, leaving them short on funds for promoting renewable energy sources. Infrastructure spending remains insufficient even with support from existing financial markets and international financial institutions (Xu et al., 2017). Hence, priority should be given to creating diversified investment and financial mechanisms to encourage private capital investments in renewable energy projects worldwide.

The problem, however, is that developing countries are less attractive to private capital (Fay et al., 2021). Energy projects provide public goods with great externalities. Their high entry barriers and modest investment returns discourage private investors — unless policy incentives come into play. According to the PPI database of the World Bank, private financing for renewable energy investments has grown over the past 20 years in BRI countries, but the rate is slowing down. The question then becomes how to encourage private green investment through the BRI.

Under the "Green Silk Road" initiative, Chinese companies and investors have ramped up investments in renewables. Green BRI, though advocated by China, requires broad cooperation from BRI countries. Green development is a key principle of the BRI and a shared aspiration of all BRI countries. Compared to other types of infrastructure investment, renewable energy projects are more reliant on policy incentives from host country governments because they are riskier, more capital-intensive, and offer modest returns in the early stages. Although BRI countries have implemented several policy incentives for renewable energies, it is still unknown whether these incentives help decision-making on private capital investments in green energies. Countries across the world are implementing a variety of renewables policies as their knowledge of renewable energies grows. Renewable energy markets in BRI countries are in various stages of growth with uneven levels of technological sophistication and resource endowment. This study will determine whether different renewables policies and market development stages have varied effects on the volume of private renewable energy investments.

Specifically, we will focus on four questions:

First, is there any difference in the impact of host countries' policy incentives for the renewables market on the volume of private green investments? Second, is there any difference in the efficacy of green investment policy incentives between countries at various stages of renewable energy development? Third, how will various policies for renewable energy boost green investment? Fourth, what are the potential pathways through which renewables policies may influence green investment? The answers to the above-mentioned questions will aid in the investigation of the efficacy of current

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renewables policies and the formulation of strategies to encourage private capital to provide crucial funding for green energy investments in BRI countries.

We conducted a regression analysis of mixed cross-sectional data using the probit and the cross-section models with 1,293 energy investment projects from 45 countries between 2010 and 2019 and arrived to the following conclusions: Policy incentives may persuade private capital to engage in green projects and scale up green investment. After investigating different stages of renewables market development, regression analysis indicated that renewables policies are conducive to private green investment only during the early stage of the renewables market development. When a country's renewables market is full-fledged, financing freedom becomes the driving force for private green investments, and the market begins to play a decisive role in allocating resources. Our heterogeneity analysis showed that while market incentives like renewables auctions dampen private investment in the early stage, macro-policies such as a long-term strategy help increase private investment. It was found that renewables policies encourage private green investment by expanding the renewables market. However, it is still unclear to what extent those policies inspire renewable energy innovations.

The focus on private capital participation in the "Green Silk Road" is an innovation and marginal contribution of this study. First, previous research has been mainly concerned with the way in which the BRI helped improve the environment in participating countries (Cao et al., 2020), the way it boosted China's green total factor productivity (TFP) (Liu and Xin, 2018), and how foreign direct investment (FDI) could be used to advance the green BRI. However, most studies have paid little attention to the crucial role that private capital plays in financing renewable energies. Our study fills this vacuum in the academic literature by focusing on private financing for green investments.

Second, the "Green Silk Road" calls for joint participation and mutual consultation between China and other BRI countries for shared benefits. By examining how national renewable energy policies stimulate private green investment, this study is expected to help guide host countries in improving business climate for green investment through top-down policy design, which helps overcome the funding shortfall for the "Green Silk Road". While other studies focused on a small number of countries, this paper's sample universe consisted of 45 BRI countries with diverse economic development levels and renewable energy development stages. This wide focus allows a more accurate examination of how policymaking may influence private capital investment on renewable energies.

Third, this study examines how the efficacy of renewable energy policies varies when the renewables market is in different stages of development. Even though the majority of BRI countries are developing countries, some of them enjoy the most advanced renewables markets for reasons such as resource endowment. In other words, the sophistication of a country's renewable energy industry may not be correlated with its level of economic development. Therefore, it is hard to ascertain the effectiveness of a country's renewables policies in disregard to the development level of its renewable energy market. This paper presents important policy suggestions for targeted renewables policies by situating policy efficacy within the context of the renewables market's development stage.

The rest of this paper is structured as follows: Part 2 is a review of the literature and research hypotheses; Part 3 contains a description of the model and an explanation of the data; Part 4 describes the empirical study; and Part 5 includes the study conclusions and policy suggestions.

2. Literature Review and Research Hypotheses

This section evaluates the state of existing research conducted in China and other countries on renewable energy policies, the BRI and green investment, and private capital involvement in BRI development. In this section, we will conduct a theoretical investigation of the implications of renewables policies, changes in policymaking and financial market conditions, and potential mechanisms underlying such policy effects. Based on this, we will present three research hypotheses for this study.

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2.1 Literature Review

Countries across the world have issued policy incentives including subsidized feed-in tariffs (FiT) and long-term strategies to stimulate investments and collaboration in the renewable energy industry. The impact of renewables policies on the clean energy market has also caught the attention of academics. Most other studies that explored renewables policy incentives focused on theoretical analyses and case studies (Berry & Jaccard, 2001; Gan et al., 2007; Zarnikau, 2011). Recent studies on renewable policies used econometric models. Overall, those studies discovered that policy incentives for renewable energies may augment the total installed capacity and the share of renewables (Wu et al., 2015; Zhao et al., 2013) and accelerate innovations in green technologies (Zhang et al., 2019).

Some academics have categorized renewable energy policies and discovered that the Renewable Portfolio Standard (RPS) and subsidized feed-in tariff (FiT) policies are the most effective at luring private capital investments among all renewable energy policy instruments (Friedemann et al., 2015), and that the RPS policy, despite being more effective than the FiT policy in the European market (Dong, 2012), is subject to some restrictions in the US energy market due to flaws in the policy's design (Carley, 2009). Based on their analysis of renewables market segments, some scholars have concluded that policy uncertainty will discourage developers from investing in the US photovoltaic (PV) industry (Tsvetanov, 2019), and that policy discontinuity will also result in investment fluctuations in the US wind power market (Barradale, 2010).

Some researchers have focused on less developed countries and regions, which began to place more weight on the renewable energy market. Based on their study on the effectiveness of renewable energy policies in the Caribbean islands, Kersey et al. (2021) found the net metering tariff to be the most effective at increasing the total installed capacity of renewables. Based on their study on countries with different levels of economic development, Zhao et al. (2013) concluded that renewables policies would help increase the installed capacity of clean energy only for advanced and emerging economies.

The studies mentioned above, regrettably, focus on just one or a small number of nations, therefore their empirical findings may not apply to emerging economies, least of all BRI countries. Most studies only examined a single renewable energy policy, rarely considering how the policy environment influences renewable energy investments. Prior research examined the heterogeneity of policy efficacy across countries with various levels of economic development, overlooking how such policy efficacy is subject to the sophistication of the renewable energy market. Based on a broader scope of samples, this report uncovers how national policy incentives for renewable energy spurred private capital investment for countries with varied levels of renewables market development.

The Belt and Road Initiative (BRI) in the new era has made going green a prominent theme, particularly in the context of global low-carbon and sustainable development. Green BRI has become the subject of increasing academic research. The BRI has been shown to help both the home and host countries, as evidenced by environmental improvement (Cao, 2020) and industrial upgrade (Zhang et al., 2021) in host countries, as well as green TFP and corporate green transition for China (Liu and Xin, 2018; Yang and Li, 2021). To further the BRI's green development, some scholars have studied how to implement the "Green Silk Road" from the perspectives of environmental law and clean energy diplomacy (Li, 2020; Sun, 2017). Researchers have examined the potentials and influencing factors of China's green outward direct investment (ODI) and found that the BRI has a favorable effect on green investments (Cheng and Qi, 2021; Liu et al., 2020). Other studies evaluated the risks of investing in renewable energy in BRI countries using the TODIM approach (Hashemizadeh et al., 2021).

Academics have shown great interest in the role of private capital in BRI development. Some have attributed the success of public-private partnership (PPP) infrastructure projects to host countries' project operational experience (Luo et al., 2017) and industrial concentration (He et al., 2021), the private sector's share of risk assumption (Luo et al., 2017), and the project finance model (Patricia G.

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and Francesca M., 2010). Others discussed how to beef up private capital spending on infrastructure projects in BRI countries (Qiu et al., 2021; Deng and Chen, 2018; Xu and Du, 2018). Notably, the research literature has paid little attention to private capital investments in renewable energy sources in BRI countries. The profit-seeking nature of private capital means that it is highly sensitive to changes in policies such as subsidies for renewable energy sources in host countries. However, few studies have considered the policy effects on the amount of private capital investments in renewables in BRI countries. This study will conduct an empirical investigation to fill this gap by unraveling how host countries' renewable energy policies affect the volume of private green investments. Our empirical findings are intended to supplement existing research literature.

2.2 Research Hypotheses

Renewable energies are recognized by the international community as a common choice for the global energy transition. Countries should incentivize market entities and adopt market-based solutions to expedite renewable energy development. There is a broad range of public policies for the renewable energy market, as can be seen in the compilation of renewable energy policies by the International Energy Agency (IEA), the International Renewable Energy Agency (IRENA), and the existing research literature (Kersey et al., 2021; Polzin et al., 2019). This study categorizes the common renewables policies of BRI nations into four groups: Macro-policies, market-based policies, economic subsidies, and supportive power grid policies.

For policy definitions and descriptions, please refer to Table 1.

The BRI countries have in recent years implemented macro-policies, most notably long-term strategies for renewable energies, in an effort to reach carbon neutrality and build a clean, low-carbon, secure, and effective energy system. Such policies are intended to promote the long-term development of national energy markets. They usually include a country's goals for installed renewable energy capacity and carbon emissions abatement for the next decade.

Table 1: Summary of New Energy Policies

Category	Policy title	Definition
Macro-policies	Long-term strategic plan for renewable energy development	Issuance of a national strategy to specify the goals of national renewable energy development for a certain future period, including for instance, the share of renewables in the national energy mix and the installed capacity of renewables
Economic subsidies	Direct fiscal subsidies	Grants from the government to businesses involved in the development, financing, and management of renewable energy projects
	Tax preferences	Tax preferences to renewable energy projects through tax credits or VAT deductions
	Subsidized feed-in tariffs (FiT)	State subsidies to bring down the cost of renewables-based power generation to grid parity to offset the high operational costs of renewable energy projects and ensure their stable revenues in the long run
Market-based policies	Renewable energy auctions	The state power authority chooses renewable energy producers through open bidding to set electricity tariffs and production rates through market-based competition
Supportive power grid policies	Mandatory grid connection policy	The power grid company provides non-discriminatory or priority grid connection for renewables-based electricity while ensuring the security of power grid operation.
	Power grid infrastructure support policy	Extending financial support to the construction of power grid infrastructure or easing restrictions on eligible entities to invest in power transmission and distribution networks

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On the other hand, economic incentives including tax breaks and subsidized feed-in tariffs are commonly used for the renewables markets in BRI countries. Private capital is primarily concerned with the financial return of renewable energy projects. In less developed BRI countries with greater price elasticities of demand for electric power, renewable energy projects are more dependent on public subsidies to sustain revenues (Maianne et al., 2021). Local government allowances may be an efficient way to lower the risk of private capital investment in renewables and encourage green technology innovations (Zhang et al., 2019).

Clean energy power generation is now more affordable than traditional coal and natural gas power generation thanks to economies of scale and technological advancement. The renewables market is shifting from dependence on subsidies to market-based competition. This transition is particularly evident in some advanced economies with mature technologies and in the PV and wind power sectors. In some BRI countries, market-based incentives like renewable energy auctions and performance allowances have started to gain popularity.

By the end of 2018, 106 countries had purchased renewable energy through auctions (International Renewable Energy Agency, 2019). For instance, the Philippine Electric Power Authority sets maximum tariff rates before each round of tendering and, following an assessment of the power generation volumes and tariff rates specified in the bid documents, awards contracts to bidders with the lowest marginal costs, who will then enter into a long-term power purchase agreement (PPA) with the local power distribution company. Competitive power purchase policy for renewables contributes to lowering the cost of clean energy power generation through open market competition. Long-term power purchase agreements help reduce investment risk. Put together, these initiatives have supercharged renewable energy development across the country. Based on the above, this paper proposes Hypothesis 1:

Hypothesis 1: By implementing a renewable energy strategy, BRI host countries may boost private green investments.

The BRI countries are at diverse levels of development of renewable energy, with varying degrees of economic strength and renewable energy resources. Bird et al. (2005) used the amount of renewables-based power generation as the criterion for identifying a country's stage of renewable energy development. Marques et al. (2010) used the percentage of renewables in a country's energy mix as the criterion. The percentage of power generation from renewable sources has been used by Ma and Huang (2022) and Romano et al. (2017) to gauge a nation's level of renewable energy development. In this study, the proportion of electricity generated by renewable sources is used to assess a country's level of renewable energy development. Our research samples of BRI countries are categorized into the fledgling stage if renewables-based power generation accounts for 0% to 30% and the mature stage if this ratio exceeds 30%.

Countries focus on technological innovation and market exploration in the early stage of developing its renewable energy sector (Surana and Anadon, 2015). Incentives from host country governments could be a major force behind the energy transition towards renewables in the early stage when market mechanisms for renewable energy are incomplete; renewables-based power generation is more expensive than conventional energy sources, and less attractive and affordable for consumers (Fan and Yi, 2021).

The cost differences between renewable energy and conventional energy power generation continue to get closer as a result of technology advancement and economies of scale. Additionally, as government policy incentives recede, the renewables sector transitions from policy-driven to market-driven development (International Energy Agency, 2016). At this point, the government must unleash market dynamism to further the development of renewables - an endeavor in which financial markets will be crucial for the reasons listed below.

First of all, as renewable energy projects are capital-intensive with a long payback period, investors need long-term financing arrangements to ease their financial strains (Kim & Park, 2016; Mainanne et al., 2021).

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Second, the demand for funds from renewable energy developers will increase as the market for renewable energy expands. Financial markets will help ease the shortage of funds for private investors by providing equity financing and lowering borrowing cost (Egli et al., 2019; Ji and Zhang, 2019; Shahbaz et al., 2013).

Third, there will be more competition and less variation in construction costs among different renewable energy companies as soon as the renewables market reaches a more advanced level; at that point, the cost of capital becomes a key determinant of competitiveness and investment return. Therefore, when the industry reaches a mature stage, financial markets will become the primary force behind the development of renewable energy sources. Thus, we propose Hypothesis 2:

Hypothesis 2: In the early stage of the development of renewable energies, host countries introduce policy incentives as the biggest attraction for private investments in renewables; in a more advanced stage, however, financial markets and other market-based mechanisms will play a significant role in driving those investments.

Following are some ways that policy incentives for renewables could boost private green investments:

First, policy incentives may support early-stage market development. In the early stage, renewable energies are less competitive since they are both costlier and riskier than conventional energy sources. Public acceptance of renewable energies is also hampered by a lack of environmental awareness and the high cost of producing clean energy (Almulhim, 2022). At this stage, the government should implement a range of policy initiatives to support the renewable energy industry. The *Energy Policy Act* and the *National Renewable Energy Strategy*, among other broad policy frameworks, have elevated renewable energy to a status on par with conventional energy at the legislative level, showing the commitment of relevant countries to renewables (Terrados et al., 2007). Legislation has opened up a new stage for the development of the renewable energy market. The cost of developing renewable energy has significantly decreased thanks to direct economic support at the policy level, such as subsidies, tax breaks, and low-interest loans (Ozdemir et al., 2020). Policy dividends encourage additional private capital to invest in renewable energies, leading to the renewables market's continued growth.

The second channel is technological innovation, which is essential for making clean energies cheaper and more efficient to speed up the energy transition. Governments should establish a policy environment that supports innovation. Carbon trading will, from a policy standpoint, give renewable energies a competitive advantage over traditional fossil fuels by increasing the tariff rates for the latter, encouraging market actors to invest in the industrial chains from upstream to downstream links (Qi and Zhang, 2019). By internalizing the environmental cost and lowering the risk of technology development, carbon trading may also encourage the development of low-carbon breakthroughs (Cong and Wei, 2010; Friedmann et al., 2015; Rogge and Hoffmann, 2010). In addition, countries have initiated budgetary spending on clean energy R&D to promote its development, and some use revenues from carbon auctions to support clean energy R&D (Qi et al., 2018). Considering this we propose hypotheses 3a and 3b:

Hypothesis 3a: Renewable energy policies will help a country expand its renewable energy market.

Hypothesis 3b: Renewable energy policies will spur a country's renewable energy innovations.

3. Model Specification and Data Explanation

The volume of private capital investments in the renewable energy sector as well as investment decisions are influenced by host countries' renewable energy policies. This paper explains the data sources used in the empirical research and develops two models to analyze how host countries' renewable energy policies relate to private green investments in BRI nations.

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3.1 Model Specification

Model 1: In what way will a host country's renewable energy policies influence private green investment decisions?

Referencing Luo et al. (Luo et al., 2017), the following equation is used to construct a typical probit model to analyze how host countries renewables policies influence decisions for private green investment:

$$Pr(Green=1)=\Phi(\alpha_0+\alpha_1\times Policy_{it}+\alpha_2\times Control_1+\varphi_t+\gamma_c+\varepsilon) \quad (1)$$

In equation (1), the binary choice variable *Green* has a value of 1 when private capital invests in a renewable energy project and a value of 0 when it does not. The investment projects discussed in this paper that use renewable energy as a primary energy source include solar power, hydropower, wind power, biomass, geothermal power, and biogas. Key explanatory variable *Policy* quantifies country *i*'s level of policy activity in year *t* for the renewable energy sector. The project characteristic variable and the host country characteristic variable are both included in this benchmark model as a control variable ($Control_1$). Among them, the project characteristic variable includes the installed capacity of renewable energy projects (*Capacity*), access to credit from multilateral financial institutions (*Multi*), and project risk profile (*Risk*); host country characteristic variables include host country GDP (ln*GDP*) and GDP growth rate (*GDPgrowth*) to control for the impact of the host country's economic development level on the green investment decisions of private capital. In addition, the fixed effect of year (φ_t) and the fixed effect of region (γ_c) are introduced to include the impacts of unobservable factors on the regression result. ε is the stochastic disturbance term.

Model 2: In what way will a host country's renewable energy policies affect the amount of private capital invested in renewable energies?

$$\ln Investment=\beta_0+\beta_1\times Policy_{it}+\beta_2\times FinFreedom_{it}+\beta_3\times Control_2+\theta_t+\sigma_c+\mu \quad (2)$$

The key explained variable in Model 2 is the volume of private capital investments in renewable energy projects (lnInvestment). The definition of policy is the same as in Model 1, and the explanatory variable *FinFreedom* is a measure of country *i*'s financial freedom in year *t*. Two types of control variables are included in $Control_2$ at the project and host country levels, respectively. In particular, project-level variables include the installed capacity of renewable energy projects (*Capacity*) and availability of support from multilateral financial organizations (*Multi*); variables at the host country level include those in Model 1 and the variable of host country governance, which is expressed by the three indicators - corruption control (*AntiCorrupt*), public voice (*Voice*), and political stability (*Stability*). Model 2 controls for the impact of unobservable factors on the regression results by introducing the fixed effect of time θ_t and the fixed effect of country σ_c, and μ is stochastic disturbance term.

3.2 Data Explanation

The World Bank's private participation in infrastructure (PPI) database, which contains data on 10,421 projects in 127 middle- and low-income countries between 1990 and 2020, serves as the source for the study samples used in this paper. According to Luo et al. (2017), it is currently the most trustworthy data source for information on private capital infrastructure investments in developing countries and has the largest sample size. It covers the main infrastructure sectors, including energy, transportation, water conservation, and information and communication technologies.

This study examines the energy investment projects of the 45 BRI countries in the PPI database between 2010 and 2019 (see Table 2), focusing on the four key data points listed below:

(i) Energy attributes: Non-renewable and renewable energy projects are both included in the PPI database of energy projects with private capital participation in BRI countries. Renewable energy projects include solar energy, hydropower, wind power, biomass, geothermal, and biogas projects, while non-renewable energy projects include petroleum, natural gas, and coal-fired power plants.

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Table 2: Regional Distribution of Projects under Research and Grouping by Income Level

Country	Region	Income level	Country	Region	Income level
Algeria	Middle East and North Africa	Medium-high	Indonesia	East Asia	Medium-low
Iran	Middle East and North Africa	Medium-high	Peru	Latin America and the Caribbean	Medium-high
Morocco	Middle East and North Africa	Medium-low	Jamaica	Latin America and the Caribbean	Medium-high
Egypt	Middle East and North Africa	Medium-low	Costa Rica	Latin America and the Caribbean	Medium-high
Serbia	Europe and Central Asia	Medium-high	Dominican Republic	Latin America and the Caribbean	Medium-high
Türkiye	Europe and Central Asia	Medium-high	Ecuador	Latin America and the Caribbean	Medium-high
Russia	Europe and Central Asia	Medium-high	Angola	Sub-Saharan Africa	Medium-low
Romania	Europe and Central Asia	Medium-high	South Africa	Sub-Saharan Africa	Medium-high
Bulgaria	Europe and Central Asia	Medium-high	Kenya	Sub-Saharan Africa	Medium-low
Kazakhstan	Europe and Central Asia	Medium-high	Cameroon	Sub-Saharan Africa	Medium-low
Ukraine	Europe and Central Asia	Medium-high	Zambia	Sub-Saharan Africa	Medium-low
Sri Lanka	South Asia	Medium-high	Côte d'Ivoire	Sub-Saharan Africa	Medium-low
Thailand	South Asia	Medium-high	Nigeria	Sub-Saharan Africa	Medium-low
Vietnam	South Asia	Medium-low	Senegal	Sub-Saharan Africa	Medium-low
Pakistan	South Asia	Medium-low	Zimbabwe	Sub-Saharan Africa	Medium-low
Bangladesh	South Asia	Low	Mali	Sub-Saharan Africa	Low
Nepal	South Asia	Low	Mozambique	Sub-Saharan Africa	Low
Malaysia	East Asia	Medium-high	Sierra Leon	Sub-Saharan Africa	Low
China	East Asia	Medium-high	Ethiopia	Sub-Saharan Africa	Low
Cambodia	East Asia	Medium-low	Chad	Sub-Saharan Africa	Low
Laos	East Asia	Medium-low	Rwanda	Sub-Saharan Africa	Low
Mongolia	East Asia	Medium-low	Uganda	Sub-Saharan Africa	Low
The Philippines	East Asia	Medium-low			

Source: The World Bank's PPI database.

(ii) The amount of private capital invested in renewable energy projects.

(iii) The year the project was implemented. This means the year in which the project's financing was finalized through the execution of a legally binding contract between the government and private capital, which covers critical issues like risk assumption, the division of rights and responsibilities, and the financing strategy.

(iv) Project installed capacity: This metric illustrates the size of a project. A greater demand for investment results from more installed capacity.

The key explanatory variable *Policy* in this study is taken from Regulatory Indicators for Sustainable Energy (RISE) of the World Bank. The RISE database assesses 138 countries' access to electricity, availability of clean cooking fuels and technologies, energy efficiency, and renewable

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energy sources. Seven sub-indicators have been developed for the renewable energy sector, including the legal framework (*Legal*), long-term strategic plan (*Plan*), incentive policies (*Incentives*), auction policies (*Auction*), support for internet access (*Connection*), financing support policies (*Finance*), and carbon pricing (*Carbon*). For a country's renewable energy policy sub-indicators, closed-end questions (answers are either yes or no) were created, and values were assigned based on the responses from industry insiders or experts. To acquire data of variables, the weighted average scores of the individual sub-indicators were then taken. Higher values indicate stronger policy actions for the renewable energy market.

FinFreedom, the explanatory variable for Model 2, is from the US Heritage Foundation. This variable assesses the degree to which a country's banks and other financial institutions operate efficiently without interference from the government. Financial institutions may offer individuals and businesses credit, deposits, foreign exchange, and other services in a market-based way with little to no government interference when government actions in financial institutions are restricted to corporate supervision and fraud prevention. Higher values of financing freedom indicate that resources are more productively allocated through the nation's financial markets in a market-based manner.

The host country's governance variable comes from the World Governance Indicators (WGI) of the World Bank, and the economic volume (*lnGDP*) and growth (*GDPgrowth*) variables are from the World Bank's database. In accordance with above specifications, Model 1 in this study comprises 1,293 energy investment projects as research samples, while Model 2 includes 1,010 renewable energy investment projects.

Tables 3 and Table 4 display the variable descriptive statistics.

Table 3: Descriptive Statistics of Variables in Model 1

Variable	Observations	Mean Value	Standard deviation	Min.	Max.
Green	1,293	0.830	0.376	0.000	1.000
Policy	1,293	40.420	19.700	1.000	86.000
Multi	1,293	0.193	0.395	0.000	1.000
Risk	1,254	7.736	1.183	2.000	12.000
Capacity	1,293	230.300	879.800	0.500	12900.000
GDPgrowth	1,293	5.454	2.681	-4.387	12.320
ln*GDP*	1,293	6.182	1.940	1.079	9.571

Table 4: Descriptive Statistics of Variables in Model 2

Variable	Observations	Mean Value	Standard deviation	Min.	Max.
ln*Investment*	1,010	4.178	1.203	0.148	7.601
Policy	1,010	41.910	20.230	2.000	86.000
FinFreedom	1,010	42.510	14.110	10.000	70.000
Multi	1,010	0.198	0.399	0.000	1.000
Capacity	1,010	65.020	102.500	0.500	1360.000
AntiCorrupt	1,010	-0.396	0.327	-1.421	0.762
Voice	1,010	-0.688	0.806	-1.802	1.152
Stability	1,010	-0.625	0.660	-2.810	0.841
GDPgrowth	1,010	5.481	2.767	-1.590	12.320
ln*GDP*	1,010	6.365	2.022	1.079	9.571

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4. Empirical Research

This section runs a benchmark model regression based on the prior theoretical analysis to show how renewable energy policies affect private capital investment decisions. It then conducts a robustness test and a heterogeneity analysis to discuss the robustness of benchmark results and the variations of results across samples and creates a couple of two-way fixed-effect models to further explore the potential channels through which the host country's renewable policies may affect the size of private green investments.

4.1 Benchmark Model Regression

To validate the relationship between a host country's renewable energy policies and private capital investment, this section makes use of the two-benchmark model developed in the preceding section.

Model 1: In what way will a host country's renewable energy policies influence private capital decisions to invest in renewable energies?

The standard probit model is used as Model 1 in this study, with the intensity of the host country's renewables market policymaking serving as the explanatory variable and the binary choice variable of private green investment decisions serving as the explained variable. In order to investigate the effects of the host country's renewables policies on the green investment decisions of private capital, such control factors as the project and host country characteristic variables are included.

The benchmark regression results of how the renewables policies of a host country may affect the green investment decisions of private capital are shown in Table 5. After including the explanatory variable that affects private green investment decisions, column (1) displays the regression coefficient results. The dummy variables of time and region are included in columns (2) and (3), respectively. The results of the regression coefficient with the dummy variables of time and region simultaneously controlled for are shown in column (4). The regression results indicate that a country's renewables policies strongly influence private capital's decisions to invest in renewable energy. This has confirmed the positive impact of renewables policies on private capital's green investment decisions.

On the other hand, the size of a project and the risks taken by private capital show a significant negative correlation with the decisions made by private capital regarding green investments. In other words, when companies make green investment decisions, larger and riskier projects are less attractive. This means private capital is still testing waters when it comes to investing in renewable energy projects in BRI countries. One explanation could be that renewable energy markets in BRI countries are discouragingly less sophisticated and more costly and risky for private capital to invest in large renewable energy projects.

Model 2: In what way will a host country's renewable energy policies influence the amount of private investment in renewables?

Model 2 is concerned with the renewable energy projects in BRI countries that involve private investment and uses the investment level in such projects as the explained variable. To explore the effects of the host country's renewables policies on the quantity of private renewable investments, the host country's financing freedom is included as another key explanatory variable in addition to Model 1's.

Column (1) of Table 6 presents the regression coefficient results after including the explanatory variable for the impact on the amount of private green investments. Columns (2) and (3) include the dummy variables of time and country, respectively, and Column (4) provides the regression coefficient result with the dummy variable of time and the dummy variable of country controlled for simultaneously.

Then we move on to look at the relationship between the amount of private green investments and the host country's renewable energy policies. As can be seen from the regression results of Table 2, the core variable of the host country's renewables policies will significantly increase the amount of private

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Table 5: Benchmark Regression Results of Model 1

Variable	(1)	(2)	(3)	(4)
	Green	*Green*	*Green*	*Green*
Policy	0.0028***	0.0025***	0.0022***	0.0013**
	(0.0005)	(0.0006)	(0.0005)	(0.0007)
Multi	-0.0049	-0.0093	0.0029	-0.0059
	(0.0179)	(0.0181)	(0.0182)	(0.0182)
Risk	-0.0471***	-0.0435***	-0.0470***	-0.0406***
	(0.0066)	(0.0067)	(0.0066)	(0.0067)
Capacity	-0.0005***	-0.0005***	-0.0005***	-0.0005***
	0.0000	0.0000	0.0000	0.0000
GDPgrowth	0.0018	0.0022	-0.0005	0.0011
	(0.0032)	(0.0032)	(0.0033)	(0.0034)
ln*GDP*	0.0235***	0.0244***	0.0141***	0.0125**
	(0.0047)	(0.0047)	(0.0050)	(0.0051)
Dummy variable of time		Yes		Yes
Dummy variable of region			Yes	Yes
Observations	1,293	1,293	1,293	1,293

Note: The table reports the marginal effects of the estimated results; numbers in parentheses are standard errors; *** p<0.01, ** p<0.05, * p<0.1.

green investments, and the higher the level of financial market freedom, the more private capital will invest in renewable energy projects. The reason is that the renewable energy sector is an asset-heavy one that entails a sizable upfront investment in fixed assets as well as hefty financing costs during the operating stage. As a result, financial markets are vital for financing renewable energy projects.

The following is suggested by the regression results of other control variables: International financial institutions' participation may encourage private green investments in renewable energy projects, which are public goods and typically managed by host country governments. When the public interest conflicts with the profit-seeking nature of private capital, the government tends to maintain those projects as public goods, placing private capital in an unfavorable position. Governments hold significant sway over pricing, operational mode, and profit sources for renewable energy projects (Gong et al., 2019).

Intergovernmental financial organizations pool sovereign wealth funds from various countries and engage in negotiations with host country governments on behalf of capital-contributing countries or private capital (Luo et al., 2017). International financial institutions may strengthen the negotiating position of private capital and develop reasonable financing plans according to project characteristics to lower the political, financial, and operational risks of private capital participation in those projects, allowing private capital to increase investment in renewable energy projects. These institutions have extensive experience financing infrastructure projects and have significant global influence.

On the other side, the level of private capital may benefit from the political stability of the host countries. There are military conflicts, geopolitical dangers, and political unrest in some countries along the BRI routes (World Economic Forum, 2022). Flip-flops in national renewable energy policies and guarantees result from frequent changes in the ruling parties. Newly elected governments sometimes disregard commitments made by previous administrations. Private capital is therefore more likely to invest in politically stable BRI countries. The above findings suggest that a host country's policies on renewable energy have a significant effect in welcoming private green investments. As a result, Hypothesis 1 is validated.

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Table 6: Benchmark Regression Results of Model 2

Variable	(1)	(2)	(3)	(4)
	ln*Investment*	ln*Investment*	ln*Investment*	ln*Investment*
Policy	-0.0007	-0.0013	0.0057*	0.0088**
	(0.0017)	(0.0023)	(0.0030)	(0.0041)
FinFreedom	0.0049	0.0047	0.0198**	0.0210**
	(0.0033)	(0.0033)	(0.0086)	(0.0094)
Multi	0.5680***	0.5660***	0.4600***	0.4630***
	(0.0810)	(0.0798)	(0.0852)	(0.0860)
Capacity	0.0072***	0.0071***	0.0064***	0.0064***
	(0.0011)	(0.0011)	(0.0010)	(0.0010)
AntiCorrupt	-0.1520	-0.1770	0.2430	0.1520
	(0.1300)	(0.1340)	(0.4330)	(0.4640)
Voice	0.2360***	0.2460***	-0.2040	-0.1630
	(0.0644)	(0.0652)	(0.2970)	(0.3070)
Stability	0.1400***	0.1430***	0.5310***	0.554***
	(0.0519)	(0.0526)	(0.1920)	(0.2080)
GDPgrowth	-0.0317*	-0.0201	0.0287	0.0308
	(0.0183)	(0.0197)	(0.0229)	(0.0244)
ln*GDP*	0.1470***	0.1360***	-0.3880	-0.2240
	(0.0267)	(0.0276)	(0.3420)	(0.4350)
Dummy variable of time		Yes		Yes
Dummy variable of country			Yes	Yes
Observations	1,010	1,010	1,010	1,010

Notes: Numbers in parentheses are standard errors.

4.2 Further Analysis

4.2.1 Robustness test

(1) Exclusion of special countries

Our samples include 281 conventional energy projects (21.7%) and 275 renewable energy projects (27.5%) with private capital participation in China, which could bias the regression results. Additionally, this study intends to examine how the policy environment in BRI countries may influence private green investments in order to help reduce the gaps in the BRI countries' green finance. In order to uncover those policy effects, this section excludes Chinese samples from the overall research samples and runs another regression using Models 1 and 2. The robustness of the benchmark test is validated by the regression results in columns (1) and (2) of Table 7, which are consistent with the outcomes of the benchmark test.

(2) Replacement of explained variables

The total amount of private capital invested in renewable energy projects is chosen as the explanatory variable in Model 2's benchmark test. Such information not only covers the sum that private capital has invested in tangible assets, but also the license fees that private capital has paid to get the right to develop a project. Physical capital investments better reflect financing demand from renewable energy projects. By leveraging the private sector's expertise in everything from investment to construction and operation, host countries hope to increase their installed renewable energy capacity. For this reason, the original explained variable is replaced in this study with the amount of physical investments in renewable energy projects made by private capital (ln*Phyinvest*) to perform a regression analysis using the same methodology as the benchmark test. The robustness of the benchmark test

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findings has been validated by the results in column (3) of Table 7.

(3) Lag term of host country GDP

For the control variables of Model 2, there could be mutual causality between host country GDP and the explained variable of renewable energy investments. Moreover, a time lag may also exist for the host country's GDP to influence the volume of private green investments. With the results displayed in column (4) of Table 7, this study incorporates a one-phase lag of host country GDP to assess the robustness of the benchmark regression. The regression results demonstrate the robustness of the benchmark test and are consistent with the outcomes of the benchmark test.

4.2.2 Heterogeneity analysis

(1) Development stage of renewable energy

With regression results presented in Table 8, this paper further evaluates the role that renewable energy policies play at different stages of the renewable energy market's development on the basis of benchmark analysis in Model 2. The results of columns (1) and (2) in Table 8 indicate that when a country's renewables market is in its infancy, renewables policies will effectively attract private green investments, whereas the policy factor is no longer significant in the growth and maturity stage, when financial markets start to play a significantly positive role. Hypothesis 2 is thus proven.

(2) Types of renewable energy policies

The results of Model 2's benchmark analysis provide an explanation for why private green investments are drawn by a host country's renewable energy policies. The long-term strategic plan for renewable energy development (*Plan*), policy incentives for renewables (*Incentives*), renewable energy auction policy (*Auction*), policy support for power grid connection (*Connection*), and financing support

Table 7: Robustness Test

Variable	(1)	(2)	(3)	(4)
	Green	ln*Investment*	ln*Phyinvest*	ln*Investment*
Policy	0.0019**	0.0149**	0.0090**	0.0104**
	(0.0008)	(0.0070)	(0.0040)	(0.0044)
Control variable	Yes	Yes	Yes	Yes
Observations	978	735	988	1,010

Table 8: Regression Results after Differentiating Renewable Energy Development Stages

Variable	(1)	(2)
	Nascent stage	Growth and maturity stage
	ln*Investment*	ln*Investment*
Policy	0.0105*	0.0058
	(0.0054)	(0.0195)
FinFreedom	0.0089	0.1450***
	(0.0112)	(0.0399)
Control variable	Yes	Yes
Observations	774	193
Chow Policy	-0.0072***	
Chow Finfireedom	-0.0107***	

Note: *Chow Policy* and *Chow FinFreedom* are the Chi-square values of Chow test for the inter-group differences between the policy intensity for the renewables market and the regression coefficient of financing freedom.

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policy (*Finance*) are the five national renewable energy policy sub-indicators used in this section's analysis of the role of specific policies in luring private capital. We run a further regression of Model 2 to examine the role of specific policies in attracting private capital. Column (1) of Table 9 displays the regression's results. The regression results show that a long-term strategy for renewable energy encourages private capital to invest more in renewable energy. By establishing a long-term strategy for renewable energy growth, the host country government demonstrates its commitment to expanding the renewable energy sector, possibly through increased economic support that appeals to private capital.

The green investment attraction effects of specific renewable energy policies at various stages of renewable energy development are further examined in columns (2) and (3) of Table 9. It has been discovered that a long-term strategy attracts private capital in all stages of renewables market development, whereas the renewables auction strategy considerably discourages investment in the early stage. The auction policy aims to lower the cost of producing clean energy power through competitive market forces. Such competition discourages private green investments by putting a strain on project cash flow in a nascent renewables market still dependent on subsidies.

4.3 Potential Policy Effect Pathways

After the benchmark study has demonstrated the effectiveness of renewable energy policies in attracting private green investments, this section will delve into the mechanism of such policy effects.

Table 9: Regression Results for Different Types of Renewable Energy Policies

Variable	(1)	(2)	(3)
	Total samples	Nascent stage	Growth and maturity stage
	ln*Investment*	ln*Investment*	ln*Investment*
Plan	0.0150***	0.0171**	0.0188*
	(0.0050)	(0.0080)	(0.0104)
Incentives	-0.0068	-0.0125	-0.0073
	(0.0052)	(0.0087)	(0.0153)
Auction	-0.0154	-0.0515***	-0.1120
	（0.0168）	（0.0230）	（0.1460）
Finance	0.0046	0.0107	-0.0014
	(0.0055)	(0.0081)	(0.0148)
Connection	-0.0101	0.0356	-0.0643
	(0.0166)	(0.0243)	(0.0708)
FinFreedom	0.0271***	0.0184	0.0733
	(0.0093)	(0.0124)	(0.0563)
Control variable	Yes	Yes	Yes
Observations	1,010	774	193
Chow Plan		-0.0084***	
Chow Incentives		-0.0096***	
Chow Auction		-0.0418***	
Chow Finance		-0.0084***	
Chow Connection		-0.0115***	
Chow FinFreedom		-0.0130***	

Note: Chow Plan, Chow Incentives, Chow Auction, Chow Finance, Chow Connection, Chow FinFreedom are the Chi-square values from Chow test for the inter-group differences of the renewables policy sub-indicators and the financing freedom regression coefficient.

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(1) Policy effects on the renewable energy market

The model specification used in this study to develop a two-way fixed effect model of time and country is as follows: The total installed capacity of renewable energy (*GreenCapacity*), which is from the International Renewable Energy Agency (IRENA) database, is used to gauge the growth of a country's renewable energy sector. Only 38 of the benchmark samples are tested since not many BRI countries are in the database. Control factors ($Control_3$) consist of: (i) Environmental regulation, denoted by the stringency (*EnvStringency*) and enforcement (*EnvEnforcement*) of environmental regulation in country *i*, year *t*; (ii) governance, represented by corruption control (*AntiCorrupt*), political stability (*Stability*), and public voice (*Voice*) in country *i*, year *t*; (iii) the country's economic volume (ln*GDP* after logarithmic conversion) and economic growth rate (*GDPgrowth*).

The test results, which are displayed in column (1) of Table 10, indicate that renewables policies may significantly promote a country's renewable energy market, hence verifying 3a.

$$GreenCapacity_{it} = \beta_0 + \beta_1 \times Policy_{it} + \beta_2 \times Control_3 + \theta_t + \sigma_c + \mu \quad (3)$$

(2) Policy effects on technological innovation

The model used in this section specifies that a country's technological innovation in renewable energy is determined by the growth in the number of renewable energy patents (GreenPatent). Data source for this model is the IRENA database, which covers the complete data of 14 countries for almost ten years. Those 14 countries therefore serve as test samples in this section. The GreenPatent variable has the logarithmic form of +1 in order to increase the regression model's goodness of fit due to disparate numbers of new green patents in different countries, with some of them registering no green patents in some years. Control variables ($Control_4$) include: (i) Environmental regulation, represented by the stringency and enforcement of environmental regulation in country *i*, year *t*; (ii) governance, represented by the prevention of corruption (*AntiCorrupt*), political stability (*Stability*) and public voice (*Voice*) in country *i*, year *t*; (iii) the country's economic prowess, represented by economic volume (ln*GDP* after logarithmic conversion) and economic growth rate (*GDPgrowth*); θ_t is the fixed effect of country, σ_c is the fixed effect of time, and μ is the disturbance term.

$$GreenPatent = \beta_0 + \beta_1 \times Policy_{it} + \beta_2 \times Control_4 + \theta_t + \sigma_c + \mu \quad (4)$$

Due to the following factors, test results in column (2) of Table 10 cannot conclusively determine whether renewables policies would encourage or impede a country's technological innovation: Firstly, most BRI countries are emerging or developing economies, which are less affluent and sophisticated than developed countries. During the early stage, those BRI countries must import renewable energy technologies from industrialized nations (Kim, 2020). Therefore, national policies may not bolster innovation in any significant way in the short run. Only when the renewables market becomes more mature do national policies begin to encourage technological innovation. Second, incentives must be aimed at certain technologies to spur renewable energy innovations. Technology innovation might benefit

Table 10: Potential Pathways for the Effects of Renewable Energy Policies

Variable	(1)	(2)
	GreenCapacity	GreenPatent
Policy	1.019***	0.0106
	(0.210)	(0.008)
Control variable	Yes	Yes
Fixed effect of time	Yes	Yes
Fixed effect of country	Yes	Yes
Observations	380	140

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more from targeted policy incentives as well as from improvements to the national R&D environment.

5. Conclusions and Policy Suggestions

Based on 1,293 energy investment projects in 45 BRI countries between 2010 and 2019, this study analyses the efficacy of renewable energy policies established by BRI host countries in attracting private capital for renewable energy investments. Our findings are intended to serve as theoretical basis and policy guide for strengthening the policy environment, addressing green finance gaps for the BRI, and co-opting private capital to build the "Green Silk Road". Our findings have the following policy implications:

First, the policy incentives offered by a country may considerably encourage private capital to invest in green energy and scale up such investments.

Second, regression results reveal that renewable energy policies are attractive to green investment only when the renewables market is at its fledgling stage. When the market grows bigger and more sophisticated, financing freedom replaces other factors as the main force behind private green investments, and the market starts to hold sway in mobilizing resources.

Third, further examination and categorization of renewables policies illustrate that, while policy incentives (i.e. renewable energy auctions) significantly discourage private capital investment in the early stage of the renewable energy market, macro-policies such as a long-term renewable energy strategy may attract private capital into the renewables market in all stages.

Fourth, although renewables policies encourage market growth by inviting private capital investment, these policies do little to spark innovation in host countries. Renewable energy markets in BRI countries are at varying levels of development. For those in initial stages, establishing a more effective policy framework is crucial to advancing their energy transition. The National Energy Administration (NEA) of China estimates that in 2021, renewable energy-based power generation in China accounted for 29.8% of its total power consumption. Coordination of China's renewables policies with market-oriented reform becomes crucial as the renewables market enters the growth and maturity stage. Therefore, 'we conclude this paper with the following policy suggestions:

(i) Enhance national renewables policies. To facilitate a swift transition to renewable energies, short-, mid-, and long-term strategic goals and plans should be developed in accordance with the market potential and energy resource endowments for various forms of renewable energy. Renewable energies can be made more competitive through the adoption of market-based pilot policies such as price difference contracts, price premium subsidies, and clean energy auctions.

(ii) Coordinate market-based mechanisms with policy incentives to develop the renewable energy industry. Market-based mechanisms are expected to strengthen and policy incentives to diminish amid the falling cost of generating electricity from renewable energy sources. The development of China's renewable energy industry from early stage to mature necessitates policy priorities. Priority one is to lower the marginal cost of renewables-based power generation through open competition in the electricity spot market, making it possible to complete the transition from massive subsidies to market-based price competition with the aid of policy instruments like power purchase agreements (PPA) and auction subsidies.

On the consumption side, initiatives should be made to enhance green power certification and speed up the grid integration of renewable energy sources. Market entities should fairly share responsibility for consuming power produced from renewable sources.

Finally, even though renewable energy is the main force behind the third global energy transition, considering the national circumstances of BRI countries, renewable energies should be supplemented with coal-fired power and other conventional energies to bring about an energy market transition through electric power market reforms and enhancing market-based tariff rates.

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(iii) Harness financial market mechanisms and expand access to financing for renewable energy. Financial market development and green credit issuance should be given high priority to finance renewable energy projects. With the help of green financial solutions such as green bonds and green credit, eligible renewable energy projects could receive needed assistance. It is important to support the adoption of the BRI Green Investment Principles by the Silk Road Fund, the Asian Infrastructure Investment Bank (AIIB), and other international financial institutions. Implementation of policy financial instruments is necessary to allow claims, equities, equity-claim combinations, and private equity funds to participate in green investing. Proactive efforts should be made to explore the possibility of project financing using project assets as a payback guarantee, as well as hybrid financing with international institutions and commercial banks, in order to expand renewable energy finance and ease the shortage of funds.

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